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SCURVY VIII. FACTORS AFFECTING THE ANTI-SCORBUTIC VALUE OF FOODS[1]

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NEW YORK

For many years following the classic exposition of Barlow and the studies to which it gave rise, scurvy aroused little interest and was represented in the literature merely by a succession of case reports. Of late, however, this subject has become one of the most active from the clinical as well as from the experimental standpoint. This striking change in the status of this disorder is due largely to the publications of Holst and his co-workers,[2] who opened the field to experimental study by demonstrating that scurvy can be induced readily in the guinea-pig. It has received additional impetus through the war, which unavoidably led to the development of scurvy, not only among the troops, but among the civilian population. As there has been no account of this chapter of the medical history of the war, it seems of interest to review briefly, even at this early date, some of the reports which are accessible, and which show that, in spite of our knowledge of prophylaxis, scurvy still must be regarded as one of war's vicissitudes.

In 1917 Harvier,[3] a surgeon of the French army, was surprised to discover that 95 per cent. of the 800 troops of which he had charge suffered from scurvy; he tells us that other epidemic centers were

1. The previous articles of this series are:
   1. Hess and Fish: Infantile Scurvy: The Blood, the Blood Vessels, and the Diet, Am. J. Dis. Child **8**:386, 1914.
   2. Scurvy: A New Aspect of the Symptomatology, Pathology and Diet, J. A. M. A. **65**:1003, 1915.
   3. Infantile Scurvy: Its Influence on Growth (Length and Weight), Am. J. Dis. Child. **12**:152, 1916.
   4. The Therapeutic Value of Yeast and of Wheat Embryo, Am. J. Dis. Child. **13**:98, 1917.
   5. Subacute and Latent Infantile Scurvy. The Cardiorespiratory Syndrome (A New Sign), J. A. M. A. **68**:235, 1917.
   6. Infantile Scurvy: A Study of Its Pathogenesis, Am. J. Dis. Child. **14**:337, 1917.
   7. The Rôle of Antiscorbutics in Our Dietary, J. A. M. A. **71**:941, 1918.

2. Holst, A., and Froelich, T.: Ztschr. f. Hyg. u. Infektionskr. **72**: 1912.
3. Harvier, P.: Paris méd. **7**:394, 1917.

recognized later outside this sector. Elsewhere we read[4] of the occurrence of scurvy in France, involving 40 per cent. of 1,700 men of the South African Labor Corps and that this disorder was still more serious in another company owing to the fact that it was not recognized.[5]

Another author reports scurvy among the Italian troops,[6] giving an account of an epidemic of some 200 cases of infectious purpura with manifestations of hemorrhagic scurvy. Still another reports that in June, 1916, scurvy broke out among some Italian troops which were stationed at an altitude of 1,500 to 2,000 meters.[7] Vallardi gives an account of 180 cases among Italian troops in Macedonia, accompanied by slight jaundice and enlargement of the glands.[8]

It would seem that Germany likewise was not spared from this disorder, as is evidenced by a report of thirty cases noted by the French among prisoners of war captured in the beginning of 1917, which were once again diagnosed as purpuric rheumatism.[9] Furthermore, Morowitz[10] writes of scurvy in Germany among the soldiers, stating that it was confined mainly to the Eastern front. Both of these papers remark on the difficulty of differentiating scurvy from purpura. In this connection the statement of another German author[11] is interesting, namely, that during wars eruptions are apt to take on a hemorrhagic character; for example, in association with typhoid fever, cerebrospinal fever and rheumatism, and that this has been true in this war, in the Franco-Russian War of 1812 and in the Crimean War. He believes that, although scurvy has been prevented in this World's war, the latent type of the disease has not been eradicated. Another significant term is used by Blatt,[12] who writes of "a special department for scurvy containing about seventy patients."

It is of course not surprising to read of scurvy occurring in Russia. In the beginning of 1916, cases were reported among Russian prisoners,

4. Dyke, H. W.: Lancet, London **2**:513, 1918.

5. The writer adds that he believes that the health of the natives at home is protected by Kaffir beer which they consume even to the amount of 3 gallons a day, and which is made from germinated Kaffir corn. This cereal is germinated by steeping it in water for forty-eight hours and is then dried in the sun. Only enough is prepared for one brew. The French prepared a similar fermented beverage for these South African laborers, the sole difference in its mode of preparation being that the corn had not been germinated.

6. Vannutelli, F.: Policlinico, Rome **24**:873, 1917.

7. Gingui, F.: Riforma med. **34**:22, 1918.

8. Vallardi, C.: Riforma med. **34**:793, 1918.

9. Schreiber, G.: Paris méd. **26**:508, 1918.

10. Morawitz, P.: München. med. Wchnschr. **13**:349, 1918.

11. Von Niedner: Med. Klin. **14**:333, 1918.

12. Blatt, N.: Wien. klin. Wchnschr. **31**:942, 1918.

associated with the symptom of night-blindness.[13] Elsewhere we read of 500 cases among prisoners captured in Turkestan.[14]

The data of the occurrence of scurvy among British troops is not yet available. There are many indications, however, which lead us to conclude that they also were affected. In one article 400 cases are referred to.[15] This account likewise mentions night-blindness as a symptom, and notes the interesting fact that "scorbutic patients, when operated on, showed no particular tendency to hemorrhage." Most significant, however, are the preventive measures which were instituted by the British government. A body of 256 men, designated as the Madras Gardeners' Corps, were dispatched to Mesopotamia to plant gardens all over the country and to supply packets of seeds to various units.[16] At Bagdad alone their output of vegetables was over 400,000 pounds. This is certainly a remarkable innovation in the hygiene of armies. Another significant point referred to in this article is that a new dietary scale, increasing the amount of vegetables, has been ordered for the British troops in India. The activity during the latter period of the war of the Lister Institute in investigating scurvy must also be interpreted as the response to an urgent demand for knowledge on this subject.

The civilian population was by no means spared. Indeed, it is probable that it suffered more widely in this regard. In Glasgow we learn of fifty cases developing in the Poor Law Hospital within a period of four months,[17] and in Newcastle of sixteen cases appearing in the Poor Law Infirmary in the course of three months.[18] A recent article from Vienna describes 200 cases occurring among older children, a situation quite unheard of in peace times.[19] Morawitz[10] also states that scurvy appeared mainly among civilians.

In its fully developed form scurvy must be considered an exceptional disorder in normal times. This applies to the United States and to most of Europe. In Russia and some other countries it is practically endemic. A recent communication from Aruba,[20] a small island of Dutch Guiana lying north of Venezuela, illustrates the fact that in some parts of the world scurvy is still a plague. This note tells of 3,000 cases of this disease occurring in 1915 among a population of less than 10,000, and adds that the crops have failed almost entirely during the years 1912, 1913 and 1914.

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13. Zak, E.: Wien. klin. Wchnschr. **30**:592, 1917.
14. Disque: Med. Klin., No. 1, 1918.
15. O'Shea, H. V.: Practitioner, London (October) **1**: 1918.
16 Trop. Dis. Bull. **12**:257, 1918.
17. Pickens, R. M.: Lancet, London **2**:21, 1917.
18. Harlan, G. P.: Brit. M. J. **2**:46, 1917.
19. Tobler, W.: Ztschr. f. Kinderh. **87**:459, 1918.
20. Hopkins, G. R.: J. A. M. A. **69**:1641, 1917.

It is difficult to estimate how common scurvy, and more especially infantile scurvy, is in the United States. A recent article by McLean[21] gives an account of 50 cases admitted to the wards and outpatient department of the Babies' Hospital in New York City during a period of twenty months. Statistics, however, do not and cannot give an adequate idea of the incidence of nutritional disorders which require many months to develop fully. When we reflect that it usually requires about six months before a case of scurvy reaches the phase where it can be recognized clinically, it is clear that *the great majority of cases must be latent or rudimentary, and inaccessible to diagnosis by clinical or laboratory methods.* It would seem logical to believe that there is a considerable number of infants who for a period of one or more months are unwittingly deprived of the necessary quota of antiscorbutic food, but who are saved from the manifest development of the disorder by a casual and fortunate change in their dietary.

MILK

The most important foodstuff in connection with scurvy in infants is the essential dietary of all babies, namely, milk. If milk were highly antiscorbutic, infantile scurvy would be a most exceptional disease. As brought out elsewhere, however, "raw milk must not be considered as having potent antiscorbutic properties."[1] This was noted many years ago by Barlow[22] in one of his later papers, and has been convincingly demonstrated by the recent experimental work of Chick and Hume[23] carried out in the Lister Institute. In numerous communications published during the past few years, we have laid emphasis on the fact that pasteurized milk possesses still less antiscorbutic power than raw milk; that, indeed, it is not sufficiently rich in this "vitamin"[24] to allow a positive balance to be maintained, so that infants fed for a considerable period on pasteurized milk develop a mild type of scurvy.

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21. McLean, S.: Arch. Pediat. **35**:477, 1918.

22. Barlow, T.: Lancet, London **2**:1075, 1894.

23. Chick, H., and Hume, E.: Biochem. J. **12**:131, 1918.

24. There has been considerable discussion as to the proper generic term for the substances which are active in preventing scurvy, beriberi and other deficiency diseases. Some have preferred to use the indefinite term "accessory factor" rather than the word "vitamin," which connotes a definite chemical substance. "Accessory factor," however, leads one to infer that such a substance is not essential to well-being or to life in comparison to other food substances. In point of fact, just the opposite is true. We can prosper without fats or carbohydrates in our diet, but we cannot maintain health if the antiscorbutic factor, the antiberiberi factor, etc., are excluded from the dietary. From this point of view these substances are essentials for life, whereas the fats and the carbohydrates may be regarded individually as more truly "accessory."

We wish to point out again that this deficiency of pasteurized milk is due only in part to its having been heated, that much of the antiscorbutic factor is lost subsequent to the heating in the course of the handling and aging of the milk, so that pasteurized milk contains considerably less of the vitamin factor after forty-eight hours than it did immediately subsequent to heating. This is due in part to the fact that a large proportion of the acid-forming bacteria are killed, so that the milk gradually becomes less acid, developing a reaction which favors the loss of the antiscorbutic "vitamin." It is probably exceptional, however, for a well marked case of scurvy to develop on a diet of pasteurized milk, for enough of the protective substance remains to avert this disaster. In referring to scurvy occurring on this diet, we refer to the latent type of the disorder, characterized by stationary weight, fretfulness, a peculiar muddy complexion, rapidity of pulse and respiration (the cardiorespiratory syndrome) and slight edema over the tibiae; in some cases this condition advances further, merging into what may be termed subacute scurvy — where tenderness of the bones, scattered petechiae, and perhaps a fine hemorrhagic rim along the gums of the incisor teeth are added to complete the picture.

The more milk, whether raw or pasteurized, a baby receives, the less will be the chance of scurvy developing. This is likewise true in regard to experimental scurvy. It would seem that this fact constitutes conclusive evidence that this disorder is not brought about by an exogenous toxin existing in the milk, and also that it can be explained only on the supposition that a deficiency plays a rôle in the etiology of the disease. In considering whether a certain diet leads to scurvy, it is, therefore, of prime importance to know how much milk has been given. In most of communications, however, for example in the excellent report brought out some years ago by the American Pediatric Society, this item is not included in the data, so that it is impossible to appraise the rôle which the boiling or the pasteurization of the milk, or the addition of various proprietary foods, played in bringing about the disorder. Frequently many factors must be taken into consideration when analyzing the relation of a particular food to scurvy. For example, when we regard malt soup from this point of view (a preparation consisting of 1 pint of milk, 1 pint of water, with the addition of flour, malt and a small amount of potassium carbonate), a diet which in our experience induces scurvy most readily, we find that there are the following determinants leading to this result: the amount of milk is insufficient to fully protect; the preparation is boiled and frequently prepared originally from pasteurized milk; there is a period of aging between the pasteurization

and the boiling of the milk and the flour;[25] an alkali is added, thus hastening the decomposition of the "vitamin"; and finally, the additions to the milk may exert a detrimental influence. Some time ago, in making up malt soup preparations, raw milk was used for a certain number of infants and pasteurized milk for others. A distinct superiority was found in favor of the former as regards the development of latent scurvy, so that we would recommend that raw milk should be employed in preparing malt soup and similar formulas which involve heating.

Another milk formula which frequently leads to mild scurvy is Schloss milk, which contains 280 c.c. of milk and cream to the quart, in addition to sugar, flour, casein and potassium chlorate. Here again the small amount of milk is largely accountable for the production of scurvy, although there is probably the additional factor of low acidity, as it is only half as acid as raw milk, when measured by its power to neutralize a solution of sodium hydroxid. Reducing the acidity of a food does not entail an immediate loss of antiscorbutic vitamin, although it initiates a gradual and continuous loss of this substance. Just as we must consider exactly the nature of the diet, and more particularly the amount and quality of the milk in judging of the relation of a diet to scurvy, so in drawing conclusions as to the value of an antiscorbutic substance, the complete dietary must likewise be taken into account. It is evident, for example, that it will require less orange juice to cure a case of scurvy which has developed on a formula containing 24 ounces of pasteurized milk than one which has developed on a diet of malt soup. This point is rarely borne in mind. It is important to maintain the same viewpoint in judging those cases scattered through the literature where scurvy is reported to have developed in nursing babies. Probably one of the causative factors in these cases has been a deficiency in the amount of milk; in others, the hemorrhages associated with infection have been mistaken for scurvy.[26] There

25. Heating destroys to a greater or less degree the antiscorbutic "vitamin," so that if milk is pasteurized and also boiled, there is a double loss of this substance. However, this loss is greater if an interval is allowed to elapse following the pasteurization, for then the milk is also subjected to the deteriorating influence of age, which is considerable after prolonged heating at a low temperature.

26. There seems to be some misconception as to the pathogenesis of the subperiosteal hemorrhage in scurvy. In most reports this lesion is described as if it resulted from a hemorrhage burrowing its way beneath the periosteum and raising it from the subjacent bone. In point of fact, such an event is impossible, as will be fully realized when one experiences the great difficulty in separating periosteum from normal bone. Scurvy involves the periosteum which is not normal; it is insecurely attached to the shaft of the bone, so that it is readily stripped off by hemorrhage.

are a few reported cases, a very few, however, which are difficult to explain in these ways.

DRIED MILK

In view of the increasing use which is being made of dried milk, it seemed distinctly worth while to determine whether milk necessarily loses its antiscorbutic power in the course of drying. In their work on animal scurvy, Chick and Hume[27] employed dried milk as a part of their routine diet, as providing a well balanced ration which was devoid of the antiscorbutic factor. The milk which they used had been heated to 120 C. for an hour. It would be a mistake to infer from these experiments that all dried milk must be regarded as inert in this particular, for milk may be desiccated at a lower temperature, and one sustained for a much shorter period. We have tested a brand of dried milk which has been heated to about 116 C. for about one minute, and found that when it was given to the guinea-pig to the equivalent of 80 c.c. of fresh milk, it was able to cure scurvy. These experiments will be reported in detail elsewhere in connection with guinea-pig scurvy. We have had an opportunity, however, of testing this milk in two cases of human scurvy. The babies showed the typical signs of scurvy—peridental hemorrhage, tenderness of the femora, and the milder symptoms which we have heretofore enumerated. When the diet of the one child was changed from malt soup to 4 ounces of dried milk diluted with a quart of water, there occurred distinct improvement in all the scorbutic signs and in the general condition. In the other case the malt soup was replaced by the same quantity of dried milk solution (1 quart), to which, however, malt, flour and potassium chlorate were added according to the previous formula. In this instance likewise a decided improvement in the scorbutic signs occurred—the hemorrhages of the gums disappeared, the child soon began to stand, and her temperament became happier. It may seem that this result runs contrary to all that we know of the antiscorbutic "vitamin" and its sensitiveness to destruction by heat. We must remember, however, that there are many factors which determine whether or not heat shall bring about destruction of "vitamin." For example, it was found that orange juice can be boiled for a period of at least ten minutes and lose vary little of its antiscorbutic value.[1] Recently Harden, Zilva and Still[28] have shown that lemon juice may be reduced almost to the dry state and still retain its power. This resistance has been attributed to its acid reaction. We know, however, that cabbage may be dried and still retain

27. Chick, H., and Hume, E.: Tr. Soc. Trop. Med. and Hyg. **10**:141, 1917.
28. Harden, A.; Zilva, S., and Still, G. F.: Lancet London **1**:17, 1919.

a large amount of its antiscorbutic quality; this has been demonstrated by Holst[29] and recently proved by Givens and Cohen.[30] In this instance the acid reaction cannot be regarded as the protective influence. In the case of this dried milk we must bear in mind that it possessed a comparatively high degree of antiscorbutic power at the time of drying, which was carried out within six hours of the milking. Shortness of subjection to heat and rapidity of desiccation occasion a minimum degree of destruction. In connection with the effect of aging, of alkalinization, of heating and probably of other agencies deleterious to this "vitamin," the length of time to which it is subjected to the injurious environment is in general more important than the intensity of the process.

The recent pronouncement of the Food (War) Committee of the Royal Society[31] that the scurvy "vitamin is deficient in all dried and preserved foods" is evidently too sweeping. We shall see later that this criticism applies also in regard to a preserved food.

The fact that dried milk may largely retain its antiscorbutic value is of interest as indicating how little the milk has been changed from a biologic point of view, and therefore is important from a dietetic standpoint. It should be remembered, however, that milk heated for a long period in the course of drying loses much or all of its protective value, and furthermore, that our experience has not embraced the question of whether dried milk undergoes gradual changes in the course of a period of many months.

Babies fed on pasteurized milk must have additional antiscorbutic food in their dietary. This does not mean that human milk contains more of the antiscorbutic "vitamin" than does cow's milk, but merely that the attending circumstances render the latter less valuable in this regard. The fact that cow's milk is pasteurized or boiled, that it is not perfectly fresh and has undergone considerable handling, that it is diluted and cannot be given in full strength, all contribute to decrease its antiscorbutic potency.[32]

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29. Holst, A., and Froelich, T.: Norsk. Mag. f. Laegevidensk. **8**:989, 1916.
30. Givens, M. H., and Cohen, B.: J. Biol. Chem. **36**:127, 1918.
31. Food Committee, Royal Society: Lancet, London **2**:756, 1918.
32. It is not possible to say exactly how much raw milk a baby needs to protect it against the development of scurvy. We may, however, reach an approximate estimation of this figure. We know that it takes about 2 c.c. of orange juice to protect a guinea-pig against manifest scurvy, and about 10 c.c. to protect a baby. The ratio, therefore, between the guinea-pig and the infant in this regard would seem to be about 5 to 1. We also know that it takes about 80 to 100 c.c. daily of fresh cow's milk to protect a guinea-pig for long periods. If we assume the ratio of 5 to 1, it would therefore seem that it would require about 500 c.c., or a pint, of fresh raw milk daily as a minimum to protect the baby. (It is quite possible that a slight negative balance of the vitamin may exist unless a still greater amount is given.)

This raises the question as to just when the antiscorbutic diet should be introduced; at what age it should be added to the dietary of the bottle-fed infants. In point of fact this question is asking merely in an indirect way how long it is wise to allow a negative balance of scurvy "vitamin" to persist. Stated in this form it would seem that the answer must be that this deficiency should be allowed for as short a time as possible. In our experience there is no contraindication whatever to giving a baby orange juice (or canned tomato) when it is a few weeks of age.

FRUITS

Orange juice must be regarded as the prototype of antiscorbutics. As far as we know, it shares with lemon juice the distinction of being the most potent food in this respect. It would be of no avail, in the present state of our knowledge, to consider in detail the nature and basis of this potency. There are some results, however, brought out by recent investigations which should be borne in mind. It has been shown that orange juice preserves its peculiar efficacy after it has been subjected to boiling for a period of ten minutes; that the active factor may be extracted by means of alcohol;[33] that it is not destroyed even though the juice be evaporated almost to dryness, and finally, that the orange juice seems to have lost none or little of its efficacy after it has been deprived of the free citric acid and other acids.[34] Recently it has been stated by McCollum and Pitz[35] that the antiscorbutic power of orange juice resides in its salt constituents; that a solution containing these salts in a proportion similar to that in the natural juice will possess the same therapeutic quality. In a previous article we have shown this not to have been our experience in the scurvy of guinea-pigs,[33] and have referred elsewhere to the fact that a preparation of this kind failed to cure the scurvy of infants. In one case (baby Margolis) 1 ounce of this "artificial orange juice" was given for a period of eighteen days. This baby had a pulse ranging from 164 to 196. The addition of this solution to the dietary did not increase the appetite or alleviate the symptoms in any way, nor did it act as a laxative. The sole effect which was observed was a diuretic action. In another case, which will be referred to later in connection with intravenous therapy, this treatment in the same dosage was continued for ten days and was then discontinued, as there was no beneficial result. We feel, therefore, that the value of orange juice

33. Hess, A. F., and Unger L.: J. Biol. Chem. **35**:487, 1918.
34. Harden, A., and Zilva, S.: Biochem. J. **12**:259, 1918.
35. McCollum, E. V., and Pitz, W.: J. Biol. Chem. **31**:229, 1917.

and similar antiscorbutic substances must be looked for elsewhere than in their salt constituents. Nor is their potency essentially united with their acid reaction, for orange juice may be alkaline and yet lose little or none of its activity. For example, the following case (Chart 1):

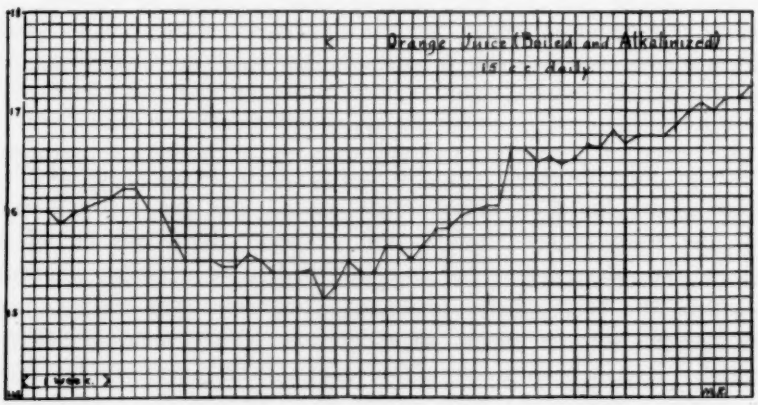

Chart 1.—Showing the cure of scurvy by means of orange juice which had been boiled and rendered alkaline previous to feeding.

Baby Kipnes, a poorly nourished baby having exudative diathesis and spasmophilia, weighed 15¼ pounds at 18 months. This baby developed subacute scurvy on a diet of malt soup which was made from raw milk. It evinced tenderness of the thighs, had the characteristic color and slight hemorrhages of the gums. From June 1 to July 10 it was given one tablespoonful of orange juice, which had been boiled and then made slightly alkaline to phenolphthalein by the addition of normal sodium hydroxid. The appetite improved rapidly, the occasional vomiting stopped and this improvement continued in spite of a mild febrile condition. When, on July 10, the raw acid orange juice was substituted, peculiarly enough the appetite lessened and there was a cessation of gain in weight (which, however, is not a reliable criterion of the value of an antiscorbutic).

Baby Hamburger, pale, had poor appetite, petechiae of the tongue and gums, and lack of gain in weight. From June 10 to July 3, a period of about three weeks, a small amount of lemon juice, one teaspoonful, was added to the dietary. The appetite remained poor, however. The dosage of the lemon juice was then increased to 2 teaspoonfuls daily for the succeeding five weeks. The baby gained and looked better. The juice was now rendered slightly alkaline, and given for the next two and one-half months in this form in the dose of 1 tablespoonful daily. The baby continuel to prosper and to be entirely free from all signs of scurvy.

The neutralization of orange juice possesses some dietetic value. At times very young babies, generally those under 1 month of age, regurgitate orange juice. It has been found that if the juice is rendered neutral this difficulty is overcome. The rendering of the juice neutral offers no practical inconvenience, as it undergoes a decided color change as soon as it has become neutral or very slightly alkaline, assuming a more translucent and far deeper yel-

low or amber color. This change may be utilized by the nurses in determining the reaction, thus rendering titration or other time consuming methods unnecessary.

In three instances we have given boiled and neutralized, or slightly alkalinized orange juice intravenously. Theoretically, there seemed no basis whatever for fearing that therapy of this kind could do any harm. The preparation is sterile, of neutral reaction, and contains sucrose and a number of salts which are present in the blood or in the organs of the body. We began with small injections, increasing them gradually, and learned very soon that the fluid was entirely innocuous. In no case was the slightest reaction noted either in the temperature or in the general condition of the child. This method was employed because it seemed that in this way a more rapid cure of the disorder might be effected than where absorption took place from the intestinal canal, and because, from a pathogenetic point of view, it would be of decided interest to determine whether or not scurvy could be cured by an extra-alimentary route. As far as we know, an endeavor of this kind has never been attempted. The first case in which use was made of this therapeutic method was that of the child (Margolis) on which "artificial orange juice" had been employed without success. After this failure mineral oil (albolene) was given for a week, nine teaspoonfuls a day. This, however, also proved of no avail. We then resorted to intravenous therapy. The orange juice was obtained in as sterile a manner as possible, boiled for about five minutes, and just previous to its injection was rendered neutral or slightly alkaline by the addition of normal sodium hydroxid. At first only a few cubic centimeters were injected. Gradually in this case and in others the dosage was increased so that as much as 30 c.c. were used at one time. In this case six injections were carried out during the period from April 29 to May 10, a total of 98 c.c. being given; that is, an average of 6.5 c.c. a day. The child showed no untoward reaction, but made decided improvement. An intercurrent infection, however, rendered it difficult to judge accurately as to the success of the treatment.

The second case in this series was another infant (Teitelbaum) to which "artificial orange juice" had brought about no beneficial result. This baby was 15 months old and had been fed for a long period on malt soup and cereal, having also received for many months 1 teaspoonful of cod liver oil three times a day. It had subacute scurvy, characterized by tenderness of the legs, hemorrhage of the gums and minor manifestations. Intravenous injections were carried out on May 1, 3, 5, 6, 8, 10, 13 and 17—87.5 c.c. being given in all. After the second injection, when 17.5 c.c. had been given,

marked improvement was noted; the gums were no longer hemorrhagic. There was diuresis accompanied by loss of weight. This loss was merely temporary and by the ninth of the month a gain set in which continued.

The third case is the most interesting and will be given in somewhat greater detail. This child (Sheratzky) was 16 months old and had hemorrhage of the gums and tenderness of the leg, which was held in the characteristic flexed and averted position. Five tests carried out on nonsuccessive days showed a daily excretion of urine of 350, 400, 200, 150 and 300 c.c. Phenolsulphonephthalein tests showed an output in the course of two hours of from 50 to 70 per cent. No casts or red blood cells were found in the urine. There was moderate anemia, 3,150,000 red cells, 70 per cent. hemoglobin, 20,000 leukocytes, of which 75 per cent. were polynuclears. The carbon dioxid tension of the lungs was 30. The chemical tests of the blood gave the following results: Urea nitrogen, 12.6; carbon-dioxid tension, 68; sugar, 0.12, and diastatic activity, 11.0. These tests were performed by Dr. John Killian and will be reported elsewhere in a paper on the chemistry of the blood in scurvy.

It seemed that this would be an excellent case in which to try the benefit of eliminative treatment. Accordingly, 6 grains a day of Dover's powder were given, an increased amount of water ordered. and the child was placed in a warm room to promote perspiration. A few days later caffein, 1½ grains, was injected hypodermically every four hours to promote diuresis, and 2 tablespoonfuls of liquid petrolatum three times a day, to increase elimination from the bowels. As there was no noticeable improvement from this treatment it seemed of advantage to attempt a cure by means of flushing out the blood stream. Accordingly, 250 c.c. of physiologic sodium chlorid solution were given intravenously and repeated on the following day. It would seem that if eliminative treatment can be successful it should be accomplished by this method. As an illustration of the extent of elimination brought about by this procedure, the following figures are of interest. At 2 p. m., when the infusion was begun, the baby weighed 15.7 pounds; at 4:05, 15.8 pounds; at 4:45, 16 pounds; the next morning it had reverted to its original weight of 15.7 pounds. In other words, all the fluid injected had been eliminated. A similar result was brought about by the succeeding injection. Throughout this period the child not only passed plenty of urine, but perspired freely and had two or three loose stools a day. The symptoms, however, grew worse rather than better, so the eliminative treatment was discontinued and intravenous injections of orange juice were resorted to. At this time, in addition to the well-known signs

of scurvy, the baby showed a positive "capillary resistance test" (that is to say, it developed petechial spots on the forearm when a tourniquet was applied for three minutes to the upper arm). Four intravenous injections were given—6 c.c., 12 c.c., 6 c.c. and 36 c.c. Improvement was noted sixteen hours after the first injection and continued day by day. In six days the child had gained 10 ounces, was less irritable and the gums were much improved. On the eighth day following the first injection it was noted that the "capillary resistance test" had become negative; how soon this change took place was not recorded. From this time on the course was uneventful. It may be added that a test of the blood of this infant showed a calcium deficiency, which, as will be shown elsewhere, occurs very frequently in this disorder.

As mentioned, these cases received not only the intravenous therapy, but what may be termed eliminative treatment. Diuresis, catharsis and sweating were stimulated with the object of bringing about the excretion of possible toxin, and thus effecting a cure. In a recent article Gerstenberger[36] has laid emphasis on the dimunition of the quantity of urine in the course of infantile scurvy, and in our preceding article we also brought out this point. In the foregoing cases our protocols show that the daily output of urine was increased by the citric acid in the "artificial orange juice," and was still further augmented by the intravenous injections of salt solution. The latter method should be of decided value in ridding the body of a toxin. In spite of a copious flushing of the blood, of the kidneys and of other organs, it did not, however, prove of value.

At the same time catharsis was brought about by means of ample doses of mineral oil (albolene). In several articles on scurvy in guinea-pigs we have shown that this disease is not due to impaction of feces, as McCollum and Pitz have suggested, and cannot be cured by means of cathartics.[37] These results have been obtained also by Rappleye[38] and by Cohen and Mendel.[39] A similar failure resulted where the mineral oil was given to babies. In the one instance (Margolis) 3 teaspoonfuls were given daily for about three weeks, and in the other for almost the same length of time. In neither case, although the bowels moved several times a day, was there the slightest improvement. Internal antiseptics were also tried, having in mind the claim that sodium benzoate is able to effect a cure in guinea-pig scurvy. *A priori* this treatment did not seem to offer great promise,

36. Gerstenberger, H. J.: Am. J. Med. Sc. **155**:253, 1918.
37. Hess, A. F., and Unger, A. F.: Proc. Soc. Exper. Biol. and Med. **15**:82, 1918.
38. Rappleye, W. C.: Boston M. & S. J. **179**:98, 1918.
39. Cohen, B., and Mendel, L. B.: J. Biol. Chem., **35**:425, 1918.

in view of the fact that so many cases of scurvy, both in adults and in infants, have been mistakenly diagnosed as rheumatism and treated without avail with large doses of sodium salicylate. Moreover, when scurvy was so prevalent on board merchant ships, the sailors were given calomel and other mercurials in immense doses and it was found that these drugs did harm rather than good. On two occasions we gave 3 or 4 grains of sodium benzoate for a period of about ten days. It is hardly necessary to give the details of these cases; the results may be summarized by the statement that no improvement was noted following this medication. We may add that one of these patients had particularly foul stools. After the failure of sodium benzoate, 1 ounce of beef juice was given daily, which, as the result of its high protein content, rendered the stool still more foul. Nevertheless, the disorder improved on the beef juice. It may be added that even after this child was completely well its stools were exceptionally foul. From these various results, both in animals and in man, we conclude that intestinal putrefaction is not at the basis of scurvy, but that the primary disturbance is a food deficiency.

In the course of some years we have tried some fruits other than the orange, notably the banana, as it is available throughout the year and is being used more largely all the time. In one case banana was given for three weeks without definite improvement, although one half of a ripe banana was fed daily to a baby 15 months of age. In another case, in which this fruit was used for almost the same length of time, only slight improvement was noted. We believe, therefore, that banana possesses but mild antiscorbutic virtue. Following the failure of treatment with banana, potato was given, in order to note comparison between two foodstuffs which are chemically very similar. Both have a high magnesium relative to their calcium content, an alkaline ash and great caloric value.[40] Only one tablespoonful of potato was given daily, but there could be no doubt that even in this amount it was superior to the banana. The banana is deficient not only in antiscorbutic "vitamin" compared to other fruits, but according to recent investigation it contains very little water soluble "vitamin."[41]

Before closing the consideration of fruits we wish to record two experiences with the use of prune juice as a curative for scurvy. Although this food did not offer great promise, it seemed worth testing in view of its availability throughout the winter. In both cases in which prune juice was given for two weeks there was no

40. Myers, V. C., and Rose, A. R.: J. A. M. A. **68**:1022, 1917.
41. Suguira, K., and Benedict, S. R.: J. Biol. Chem. **36**:171, 1918.

improvement whatever. It should be added, however, that merely one half ounce a day was given, and that had the dose been considerably larger it may well have exerted some beneficial effect. It is possible that notwithastanding drying and aging a small amount of the antiscorbutic "vitamin" is preserved.

VEGETABLES

The other main class of antiscorbutics consists of vegetables. They vary just as considerably in efficacy as do the various fruits. Those containing the "vitamin" in greatest concentration are the cabbage, the onion, and, according to recent investigations, the swede.[42] In the first article of this series by Hess and Fish,[1] two instances of mild scurvy were referred to, developing among a group of children in spite of regular daily feeding of carrots, demonstrating that a small daily ration of a vegetable not particularly rich in "vitamin" does not insure protection. In considering vegetables in this connection there are many factors which must be borne in mind. In some experiments on guinea-pigs which are about to be published it was found that old carrots did protect, clearly showing that in regard to their antiscorbutic content vegetables should not be regarded as definite entities. Such results explain, probably, the numerous inconsistencies in the reports of the treatment of scurvy with rations containing vegetables. Another important factor is the duration of the cooking process. It is evident that the older and tougher the vegetable, the longer it must be cooked, so that there is a twofold disadvantage—a food poor in "vitamin" is rendered still poorer by means of the requisite cooking. We have found that the water in which carrots have been cooked contains but a small amount of the antiscorbutic factor. A larger moiety, probably, is washed out in this process than can be ascertained, as some must have been destroyed in the water cooking. Numerous methods have been suggested to conserve the antiscorbutic value of vegetables throughout the winter months. Somewhat over a year ago Chick and Hume[23] recommended the use of germinated pulses for this purpose as suggested by Holst and Froelich.[2] For this purpose they are kept in the dried state until needed, then soaked in water for about forty-eight hours and allowed to sprout before being used as food. In this way a suitable antiscorbutic may be provided for civil or for army use, one which is not bulky and can be quickly furnished when needed. This suggestion has been successfully carried out recently in the treatment of Serbian soldiers.[43]

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42. Chick, H., and Rhodes, M.: Lancet, London **2**: 1918.
43. Wiltshire, H. W.: Lancet London **2**:811, 1918.

Some have encouraged the wide use of dehydrated vegetables, claiming that they have all the properties of fresh food. Recently Murlin[44] has urged an extended use of this product, stating that "by simply soaking in water and boiling in the same water these vegetables are brought back to the condition of fresh vegetables."

In a general review of this subject, published not long ago,[1] we said that such had not been our experience and cited reports taken from the medical histories of our Civil War and other wars, where the dependence of troops on dehydrated vegetables led to the development of scurvy. In view of the increasing importance of this subject, it may be well to give our experience in two cases:

In one instance increasing amounts of dehydrated vegetables were given daily, equivalent to 1, 2, 3 and 6 ounces of fresh carrots for a period of six weeks, without alleviating the scorbutic signs. When the amount of fresh carrots was substituted, all signs disappeared in the course of twelve days.

In another case the same lot of dehydrated carrots was given to the equivalent of 8 ounces a day, but here also there was no therapeutic effect, and when an equal amount of fresh carrots was substituted, the signs disappeared within two weeks.

An attempt to prevent the loss of the "vitamin" by immersing the carrots in a weak solution of citric acid previous to their dehydration was unsuccessful. Our experience with animals coincides with these clinical tests. We do not wish to draw the inference from these results that the dehydrating process, as such, destroys the "vitamin" but merely that in the vegetables employed, which were of excellent appearance and flavor,[45] the "vitamin" had been almost entirely lost. It is quite possible, indeed probable, that the method of preparing dehydrated vegetables will be perfected so that a product can be furnished which will be comparable in nutritional value to the fresh vegetable. Some unpublished animal experiments have shown that when carrots are dehydrated only a few hours after they are plucked, they retain considerable of their pristine antiscorbutic "vitamin." The problem seems to be one, therefore, that is open to solution. The question of the degree of heating, which is generally regarded as of prime importance, appears to be merely one of several factors. Ideal conditions for furnishing dehydrated vegetables include the use of young vegetables, dehydrating these shortly after they are plucked, keeping them well sealed until they are ready to be eaten, and probably numerous other details which must be carefully observed if deterioration is to be prevented.[46]

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44. Murlin, J. R.: Boston M. & S. J. **179**:395, 1918.

45. These carrots were prepared and kindly furnished by the Mrs. Oliver Harriman Food Research Laboratory of this city.

46. It is worth considering in this connection whether the date of the dehydration should not be stated on the package of these foods.

CANNED TOMATOES

For some time we have been looking about for an antiscorbutic which is less expensive than orange juice. In a previous publication it has been shown that a decoction of grated orange peel serves this purpose. This, however, also was not economical, so that for almost a year canned tomatoes have been employed as a substitute in the infant asylum with which we are connected. Tomatoes are not in good repute among food experts in view of the small amount of calories which they contain—only about 100 to the pound—and are regarded with suspicion amounting almost to superstition by mothers and nurses as a food for children. Although poor in calories they

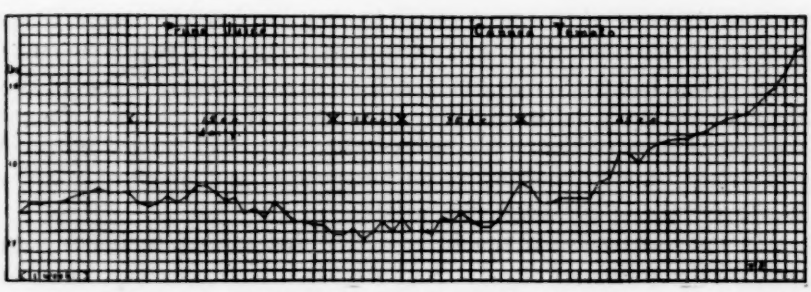

Chart 2.—Cure of scurvy by the addition of canned tomato. In this case, as frequently, the alleviation of symptoms preceded the gain in weight.

are rich in organic acid, stated by some to be mainly citric acid, by others malic acid, and contain also some salicylic acid and traces of benzoic acid.[47] It may be added, they are rich in "vitamin." Tomatoes undergo a two-fold heating in the course of canning, the second constituting the so-called "processing," during which the temperature is raised to about 230 F. The canned tomatoes were strained through a colander, warmed, and fed through a nursing bottle, one ounce daily being given to an infant a few months of age.[48] This has been the routine for all infants, and in no instance has there been the least intestinal or nutritional disturbance. From the administrative point of view, this substitute has been valuable in

47. There is no relation whatever between the acidity of canned vegetables and their possible contamination with tin. Experiments carried out to determine this question demonstrated, for example, that a "sample of red kidney beans showing the highest acidity contained the least tin," and that those samples containing the most tin were all relatively low in acidity. (Report of Conn. Agric. Exper. Station Bull. 200, 1917. J. P. Street.)

48. These tests have been controlled by a long series of experiments on animals. Groups of guinea-pigs have been fed on a diet of hay, oats and water, with the addition of various amounts of canned tomato. It was found that 5 c.c. were sufficient invariably to protect a pig from the signs of scurvy. (Proc. Soc. Exp. Biol. & Med. **15**:96, 1918.)

saving some hundreds of dollars to the institution. Babies tolerate these tomatoes exceedingly well; in some cases, indeed, the daily amount was increased to 4, 6 and 8 ounces without causing the least untoward symptom. There need be no hesitation in giving a teaspoonful of tomatoes to an infant a few weeks of age, as its acidity is only about one half that of orange juice. They may be boiled, if this is preferred, although it is quite unnecessary; cooking reduces their potency only slightly. All the infants thrived satisfactorily, many of them showing a gain greater than before tomato was substituted for orange juice. This may have been due to the fact that the former contains a considerable amount of water soluble "vitamin," which was demonstrated by means of curative tests on pigeons affected with polyneuritis. During the summer season tomatoes had to be used which had been canned almost a year previously. This aging, however, was noted not to have diminished appreciably their antiscorbutic value, probably on account of the acid reaction and method of preservation. We believe, therefore, that canned tomatoes can safely be recommended as an inexpensive and practical addition to the dietary of the bottle-fed infant.

In this connection it should be added that canned tomatoes form part of the ration of the U. S. Army, in which they can be given "in lieu of an equal quantity of potatoes, not exceeding 20 per cent. of the total issue." We have been unable to ascertain through inquiries from the Surgeon-General's Office the nature of the experience which led to their incorporation in the ration, and whether they were added specifically as an antiscorbutic. They appear for the first time in the revision of the Army Regulations of 1895. The only reference to the antiscorbutic property of canned tomatoes which we have been able to find in the literature is in the excellent treatise by Munson.[49] That the necessity of including an antiscorbutic in the ration has been recognized only in recent years may be judged by the fact that during our Civil War, and for thirty years thereafter, there was no such provision. It was stated at that time that "a general scorbutic taint pervaded the troops"—a mere euphemism for the widespread existence of subacute or latent scurvy. Even today the ration of the French and of the Italian armies makes no absolute provision in this regard, and the Russians provide merely for a variable quantity of vegetables. When we read that "during the Crimean War the temperature was never very low, and a report of the times suggests that the large number of congelations observed among the soldiers might well be regarded as gangrene owing to a scorbutic tendency exaggerated by the cold,"[49] it seems quite possible

49. Munson, E. L.: Military Hygiene, New York, 1901.

that this factor may have played a rôle in the congelations which occurred in such great numbers among the soldiers in the trenches during the great World War.

In civil life, in framing dietaries for children and for adults, our minds are still focused on insuring a sufficient supply of calories in the food, and we have not yet reacted in practice to the newer knowledge that ample carbohydrates, fats and proteins may constitute a dangerously deficient diet. This same criticism holds true for experimental work on nutrition and on infection, much of which will have to be revised to conform to our broader conceptions of nutrition.

SUMMARY

Numerous reports show that during the late war there was considerable scurvy among the troops of the various armies; least of all along the Western front. The scurvy was mainly of the latent or subacute variety and influenced the character of some of the infectious diseases, and may well have been a factor in the congelations occurring among the soldiers in the trenches. It is evident also that scurvy prevailed among the civilian population to a degree far greater than in peace times.

In infants the question of scurvy centers about the milk supply. An infant requires fully 1 pint of fresh raw milk daily to protect it from this disorder. If the milk is pasteurized, or stale, or heated for a second time, or rendered more sensitive to deterioration by means of an alkali—and particularly if more than one of these influences are operative—more than a pint is needed. The fact that there is an inverse relationship between the amount of milk consumed and the tendency to scurvy shows that we are not dealing with an exogenous toxin and argues in favor of the disorder being primarily a deficiency disease.

Milk does not necessarily lose its antiscorbutic value in the course of drying. If it is dried rapidly even at a temperature of about 240 F. it retains sufficient of the protective factor to have curative value, provided, naturally, that it was fresh at the time of drying. In considering the question of destruction of this "vitamin" by heat or by alkali, the duration of exposure to the detrimental influence is of the greatest importance.

Babies fed on pasteurized milk should receive an antiscorbutic from the time they are a few weeks of age, as there is no reason for allowing the negative balance of "vitamin" to continue for a longer period. A small amount of orange juice will answer the purpose, and is potent for a period after alkalinization. Its value does not reside in its laxative properties, nor in its salt content, as "artificial orange juice" has practically no therapeutic effect.

If orange juice is filtered, boiled, and rendered faintly alkaline it may be given intravenously without causing any slightly untoward reaction. In this way a very prompt cure can be accomplished. From a pathogenetic viewpoint a result obtained by this route is of interest as demonstrating that scurvy can be counteracted by a therapy acting quite apart from the alimentary tract.

Diuresis and catharsis do not play an important rôle in the cure of scurvy, as they may be stimulated to a high degree without alleviating the symptoms. This fact argues against regarding this disorder as essentially toxic in nature. It was found also that giving an antiseptic (sodium benzoate) was without effect.

Dehydrated vegetables were ineffective in two instances in which an equivalent amount of fresh vegetable brought about a cure. It is not to be inferred from this result that dehydration necessarily destroys this "vitamin." In this connection too much attention has been paid to the degree of the heating process, and too little to the more important factors—the age of the vegetables, their freshness previous to dehydration, their manner of preservation, etc.

For almost a year strained canned tomatoes have been given, in place of orange juice, to a large number of infants. This substitute has been found a very effective antiscorbutic, and is well borne by babies a few weeks of age. It has the advantage of low cost and availability, and therefore is of particular value for the infants of the poor.

A STUDY OF THE FAT METABOLISM OF INFANTS AND YOUNG CHILDREN

I. FAT IN THE STOOLS OF BREAST FED INFANTS*

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In recent years the examination of infants' stools, on the assumption that they represent the completeness of digestion and absorption of the different food constituents, has become a matter of great importance in the study of infant nutrition. Especially is this true in regard to the fat of the stool. It is generally believed that a knowledge of the fat content of stools and the distribution of the fat as soap, free fatty acids and neutral fat is highly desirable from a practical point of view. This knowledge is usually obtained by a superficial clinical examination of the stool and conclusions are frequently drawn from such findings which seem to us to be of questionable value.

There is, however, available in the literature a considerable amount of material which has been obtained by more complete and accurate chemical investigations. For various reasons these findings have not established a definite standard of the composition of infants' stools under varying conditions. In the first place, no very large number of stools has been reported by the same investigator. Moreover, the use of different methods for fat determination interferes with the correlation of the results obtained by various authors. Another difficulty arises from the fact that the greater part of these results have been obtained in Germany, where living conditions and methods of feeding are different from our own.

Reliable figures on the composition of stools of breast fed infants are particularly scanty. Both for this reason and because of the great importance attached to all information concerning the results of breast feeding, it has seemed fitting to begin a general study of the fat metabolism of infants and young children with the examination of a considerable number of stools of breast fed infants. The observations were made with a view to answering the following questions:

1. What is normally the per cent. of total fat and what is the distribution of fat as soap, free fatty acids and neutral fat in the stools of healthy breast fed infants?

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2. What is the difference in fat content and distribution of fat between normal and abnormal stools?

3. Does the amount and distribution of fat in the stools of healthy breast fed infants vary with the per cent. of fat in the milk and with the amount of fat intake?

The material examined consists of forty-eight collections of feces from thirty-four different infants from 10 days to 10 months of age.

Thirty of these infants were well nourished and, with few exceptions, gaining normally. In the greater number of these cases the appearance of the stools was that typical of normal breast fed infants, largely yellow, granular or pasty, very acid to litmus, with acid aromatic, not unpleasant odor. One child had stools of a peculiar dark orange color. Several of the stools showed more or less mucus and some were partly green in color. A number of the children had distinctly abnormal stools, markedly green in color and containing much mucus.

TABLE 1.—TOTAL FAT AND FAT DISTRIBUTION IN TYPICALLY NORMAL YELLOW STOOLS

Case	Age	Fat per Cent. of Dried Weight	Per Cent. of Total Fat as			Per Cent. Fat in Mother's Milk	Remarks
			Soap	Free Fatty Acids	Neutral Fat		
1. P. L. 4	6 wk.	38.7	74.8	16.6	8.6		
2. P. L. 5	9 wk.	29.3	74.0	14.6	11.4	3.8	Had also 4 tsp. dried milk at 1 feeding
3. W. C.	3 mo.	26.3	70.9	16.9	12.2	2.5	
4. P. L. 2	3 wk.	52.0	67.7	24.4	7.9	5.6	
5. M. E.	5 mo.	53.1	67.5	19.6	12.9	6.4	
6. P. L. 3	3.5 wk.	41.0	63.8	25.6	10.6	4.1	Milk showed 5.5% sugar and 1.5% protein
7. L. H.	3 mo.	29.4	60.9	24.3	14.8	1.8	
8. B. T. 1	3 wk.	43.2	57.5	23.1	19.4		
9. E. M. 1	10 wk.	32.7	56.9	21.7	21.4	5.8	
10. B. G. 1	6 mo.	43.6	53.4	32.7	13.9	2.6	
11. B. G. 3	7 mo.	57.7	52.4	30.6	17.0		
12. P. L. 1	10 da.	55.6	46.8	35.5	17.7	...	Milk colostrum; a little mucus in stool
13. B. T. 2	3.5 wk.	43.7	44.5	32.3	23.2	4.3	Milk showed 6.8% sugar and 1.4% protein
14. B. G. 2	6.5 mo.	33.7	40.8	35.5	23.7		
15. B. M.	8 da.	51.5	34.8	41.8	23.4	...	Milk colostrum
Average.....	.....	42.1	57.8	26.3	15.9		

Four of the children were acutely ill. One of these, so ill that he died two days later, had stools typically normal in appearance, although the daily amount was unusually large. The others had abnormal stools — green, watery with much mucus.

The collected stools were dried quickly on the water bath to constant weight and ground to a powder. Analyses were made for total fat and its distribution as soap, free fatty acids and neutral fat, according to the method heretofore described by us.[1]

1. Holt, Courtney and Fales: Am. J. Dis. Child. **17**:38 (January) 1919.

The stool findings for the normal children have been arranged in three groups, according to the gross appearance of the stools. The first group, Table 1, includes the analyses of the stools which were typically normal in appearance, showing neither green color nor evident mucus. Two of the infants were under 10 days old, the milk being colostrum.

It is interesting to find that in the normal stools of nursing infants the total fat forms so large a percentage of the dried weight. The average in this table is 42.1 per cent., and there are five instances in which the fat is over 50 per cent. of the total dried weight. This is considerably higher than we have generally found in the case of infants with normal digestion fed on dilutions of cow's milk. The findings as regards the distribution of fat are equally striking. The fat which is soap is high in this group, averaging 57.8 per cent. of the total fat. The neutral fat is rather low, averaging 15.9 per cent. of the total fat. The soap predominates over the other forms of fat in every case but one — an infant receiving colostrum.

TABLE 2.—TOTAL FAT AND FAT DISTRIBUTION IN GOOD STOOLS, NOT QUITE NORMAL, THAT IS, PARTLY GREEN OR SHOWING SOME MUCUS

Case	Age	Fat per Cent. of Dried Weight	Per Cent. of Total Fat as			Per Cent. Fat in Mother's Milk	Remarks
			Soap	Free Fatty Acids	Neutral Fat		
16. B. N.	7 wk.	36.0	49.6	37.5	12.9		
17. D. T.	6 wk.	61.1	47.2	35.8	17.0	2.5	
18. V. V.	5 wk.	43.9	46.0	41.1	12.9	...	Child not in good condition*
19. V. R.	3 mo.	30.8	45.2	(No separation)		3.9	Child not gaining at time
20. N. K. 2	7 wk.	18.6	41.4	35.1	23.5	2.5	
21. M. C.	8 wk.	10.7	39.7	49.5	10.8	3.3	Stool slightly fermentative
22. M. A.	4 wk.	35.7	38.3	44.6	17.1	5.6	Child not in good condition*
23. J. K.	5 mo.	32.9	36.4	46.5	17.1	6.4	
24. V. H.	9 wk.	41.3	32.9	47.1	20.0	2.0	
25. B. L.	8 wk.	44.9	31.2	55.2	13.6	5.4	
26. L. A.	5 wk.	45.4	29.0	58.0	13.0	1.4	
27. N. K. 1	6 wk.	27.3	27.5	55.8	16.7	2.5	Stools slightly fermentative
28. B. B.	11 wk.	23.3	21.4	45.6	33.0	3.0	
29. R. V.	2 mo.	43.5	20.0	53.7	26.3	5.6	Child not gaining
30. B. W.	4 wk.	38.2	19.3	51.7	29.0	2.6	
31. B. B.	.....	52.3	16.8	50.0	33.2		
Average.....	.....	36.6	33.1	47.2	19.7		

* These were normal infants but they were suffering from slight temporary indisposition.

The second group, Table 2, shows the findings in good stools which were not quite normal in appearance; that is, they were partly green in color or showed some mucus, or had both these characteristics.

In this group the total fat per cent. is somewhat lower than in the first group, the average being 36.6 per cent. of the dried weight; there are only two instances in which it is over 50 per cent., while in two it

is under 20 per cent. A marked contrast between this table and the preceding appears in the change in the proportions of free fatty acids and soap fat. In the second group the fatty acids are high, averaging 47.2 per cent. of the total fat, while the soap average is only 33.1 per cent. In two-thirds of the cases the fatty acid is the predominating form in which the fat is found in the stood. In this group the neutral fat averages somewhat higher than in the preceding group, it being 19.7 per cent. of the total fat.

Table 3 presents the analyses of a group of stools which might be considered distinctly abnormal; that is, entirely green or containing much mucus.

TABLE 3.—TOTAL FAT AND FAT DISTRIBUTION IN STOOLS WHICH WERE ENTIRELY GREEN OR CONTAINED MUCH MUCUS

Case	Age	Fat per Cent. of Dried Weight	Per Cent. of Total Fat as			Per Cent. Fat in Mother's Milk	Remarks
			Soap	Free Fatty Acids	Neutral Fat		
32. H. S. 4	11 wk.	18.1	51.9	37.4	10.7		
33. J. F.	10 mo.	12.4	51.6	24.5	23.9	3.8	Child in excellent condition; sugar in milk, 6.6%
34. B. S.	10 wk.	4.4	49.9	40.0	10.1	4.9	Child gaining; much mucus in stool
35. M. S. 3	10 wk.	35.0	45.2	35.6	19.2	...	Chalk mixture for 10 days preceding
36. B. T.	6 wk.	31.7	44.3	34.3	21.4	4.4	Much mucus in stool
37. H. S. 5	12 wk.	21.4	39.2	43.3	17.5	...	Chalk mixture for week preceding
38. E. M. 2	12 wk.	8.8	37.0	30.0	33.0	5.8	Stool normal except for much mucus
39. E. M.	3 mo.	38.3	36.8	31.3	31.9	3.9	Stool very green
40. J. W.	7 mo.	14.1	34.4	35.7	29.9	...	Child gaining slowly; milk scanty
41. J. M.	4 mo.	14.4	34.2	34.3	31.5	1.0	Child gaining slowly; sugar in milk, 5.4%
42. H. S. 2	8 wk.	18.2	27.8	23.9	48.3	...	Stool extremely acid with much mucus
43. P. W.	9 wk.	40.3	26.0	41.9	32.1	...	Stool very green with much mucus
44. H. S. 1	5 wk.	32.3	12.3	64.7	23.0	3.4	Stool extremely acid with much mucus
Average.....	.....	23.0	37.7	36.7	25.6		

The most striking feature in this table is the low per cent. of total fat, averaging 23.0 per cent. of the dried weight. In more than half the cases it is below 20 per cent. Since many of these stools consisted very largely of mucus, it is probable that the low fat per cent. is thus to be explained. The two very low figures for total fat in Table 2 may be accounted for in the same way. This type of stool is usually an indication of an abnormal intestinal condition, and under such circumstances the total daily excretion of feces is considerably increased over the normal. Hence the total daily loss of fat would be greater than occurs in children with normal stools in which the per cent. of fat is higher.

When the distribution of the fat in Table 3 is considered, it is seen that the per cent. of neutral fat is much higher than in the other

two groups, averaging 25.6 per cent. of the total fat. The average per cent. of the soap and that of the fatty acids are about the same. The five stools in which soap predominated contained much mucus, and all but one were otherwise normal in appearance.

The case, H. S., was followed for some weeks, five stools being examined. The child was well nourished and gaining normally, but had extremely acid stools, with considerable mucus, and she had a severe excoriation of the buttocks. An effort was made to reduce the acidity of the stools by the administration of chalk mixture. Observations 44 and 42 were made before any chalk mixture was given and show very low soap per cent. Before Observations 35 and 37 the child received an ounce of chalk mixture daily for over a week, with the result that the soap fat of the stools was markedly increased. Although no chalk mixture was given just before Observation 32, the effect of the preceding administration seems to have persisted.

The average of the analyses of the stools of all the children in good condition, 44 observations, included in the three tables just discussed, is as shown in Table 4.

TABLE 4.—AVERAGE ANALYSES OF STOOLS

Fat of Stool, per Cent. of Dried Weight	Per Cent. of Total Fat as		
	Soap	Free Fatty Acids	Neutral Fat
34.5	43.1	36.7	20.2

This may be taken to represent an average stool of the breast fed infant in good condition.

It must be borne in mind that this average includes the analyses of not only the typically normal stools, but others not quite normal and some that were markedly abnormal in appearance. It is the more striking, therefore, that the fat constitutes over one-third of the dried weight and that the soap is over 40 per cent. of the total fat. Even when allowance is made for an increase in the proportion of soap which takes place during drying, the average soap fat is found to form at least one-third of the total fat of the stool.

Table 5 presents the results of the examination of the stools of four infants who were seriously ill.

Two observations show very high per cent. of total fat, in stools which were very different in appearance. One was large, green and watery; the other was approximately normal in appearance, but the daily amount was large. In both the per cent. of total fat is about the same as in a number of the normal stools, but the abnormal character is shown in the distribution of the fat. The soap is extremely low, much lower than is found in the stools of normal infants. The neutral fat and the fatty acids are both very high. The other two

cases show a very low percentage of total fat. The stools were green, watery and contained much mucus. Both these infants had a very low fat intake. One child was so ill that he nursed very little, and the other received milk with a very low fat content. In the stools of both these infants the soap per cent. of total fat is also very low.

A study of Tables 1 to 5 suggests an answer to two of the questions stated in the beginning of the paper, first, the normal per cent. of total fat and the distribution of the fat as soap, free fatty acids and neutral fat, and, second, the difference in fat content and distribution between normal and abnormal stools.

The fat per cent. of dried weight of the normal stools is high, usually over 30 per cent., and frequently reaches 50 or 60 per cent. with infants whose digestion is excellent. As the stools depart from the normal the per cent. of fat usually diminishes. When the fat per cent. is low it may be suspected that the stool contains an abnormal amount of mucus.

TABLE 5.—Total Fat and Fat Distribution in Stools of Sick Infants

Case	Age	Fat per Cent. of Dried Weight	Per Cent. of Total Fat as			Per Cent. Fat in Mother's Milk	Remarks
			Soap	Free Fatty Acids	Neutral Fat		
45. J. D.	8 mo.	57.1	11.0	56.3	32.7	3.4	Ileocolitis, scurvy; stool normal in appearance
46. H. F.	6 mo.	53.7	6.6	49.6	43.8	4.5	Eczema, diarrhea; stool green, watery, fat curds, mucus
47. C. V.	5 mo.	17.2	20.5	(No separation)		0.9	Eczema, erysipelas, diarrhea; stool green watery
48. J. B.	7 mo.	17.0	29.2	42.7	28.1	...	Syphilitic, temporarily very ill from reaction after salvarsan; child was well nourished

In the best stools the soap fat regularly exceeds in amount the other forms of fat and constitutes on the average nearly half the fat of the stool. Folin and Wentworth[2] have called attention to the possibility that during the process of drying a moist acid stool on a water-bath, a change may take place in the relation of the free fatty acids and the soaps, as a result of the volatilization of the lower acids, derived from sugar, such as lactic and acetic acids. On this account we have analyzed for comparative study a large quantity of composite stool obtained from about twelve breast fed infants. This composite stool appeared to be fairly representative of normal and nearly normal stools. It was found that although there is an increase of soap at the expense of the free fatty acids in the dried specimen, yet this difference is not great enough to alter our conclusion, founded on the analysis of the dried stools, namely, that in the best stools of breast fed infants the

2. Folin and Wentworth: Jour. Biol. Chem. 6:421, 1910.

soap fat predominates over the other forms of fat. The results of the analyses of the composite stool, part of which was examined fresh and part of which was analyzed after drying on the waterbath, are as in Table 6.

In very acid stools which show even when dried a very low per cent. of soap, the difference between the analyses of the moist and dried material might be even greater than was found in the above-mentioned sample. In an alkaline composite stool, from children fed on cow's milk dilutions, no change in the distribution of soap and free fatty acids was caused by the drying process.

The increased difficulty of manipulation and the inconvenient necessity of making analyses immediately make it less desirable to work with the fresh stool. Hence, the use of dried material is more practicable, but the results must be interpreted with due consideration for the effect of drying on the relative proportions of free fatty acids and soap. From the foregoing investigation it would seem that, on the average, the soap value as determined in the dried stool should be decreased by about 10 per cent. of the total fat and the fatty acids correspondingly increased in order to represent conditions in the fresh stool.

TABLE 6.—ANALYSIS OF COMPOSITE STOOL

	Fat per Cent. of Dried Weight	Per Cent. of Total Fat as		
		Soap	Free Fatty Acids	Neutral Fat
Fresh sample.....	44.6	44.6	35.9	19.5
Dried sample.....	46.3	55.8	25.4	18.8

The neutral fat is normally less than 20 per cent. of the total fat. When the proportion of neutral fat is much higher than 20 per cent., an abnormal intestinal condition is indicated.

The variation in the fatty acids is striking. As the stools depart slightly from the normal the fatty acids are found to be increased at the expense of the soap fat; in those which are markedly abnormal the neutral fat is raised at the expense of the free fatty acids.

Abnormal stools are of two classes with respect to fat content: (1) Those containing much mucus with a low per cent., and (2) diarrheal stools, in which the fat per cent. is high, the result of poor absorption. Under abnormal conditions the per cent. of total fat which is soap is regularly low, while the neutral fat is high.

In thirty-two of the cases studied the per cent. of fat in the mother's milk was determined.[3] These figures are incorporated in Tables 1 to 5.

3. A slight modification of the Babcock method was used to determine the fat per cent. of breast milk. It was found that when 17.6 c.c. of sulphuric acid, which is the rule in determining the fat of cow's milk, was used with breast milk the fat became charred and did not give a clear separation. If the amount of acid is reduced to 13 or 14 c.c. a clear separation of fat is obtained.

No constant relation is shown between the percent. of fat in the milk and the per cent. and distribution of fat in the stool. There is possibly a slightly higher fat per cent. in the stools of the infants who were receiving milk higher in fat, but the distribution of the fat of the stool does not seem to be influenced by the per cent. of fat in the milk taken.

In only 13 cases was the exact daily intake of fat known. These are shown in Table 7.

TABLE 7.—Relation of Fat Intake to Fat Excretion and Distribution in the Stool

Case	Fat Intake, Gm. Daily	Fat per Cent. of Dried Weight	Per Cent. of Total Fat as		
			Soap	Free Fatty Acids	Neutral Fat
38. E. M. 2	42.5	8.8*	37.0	30.0	33.0
6. P. L. 3	41.9	41.0	63.8	25.8	10.6
4. P. L. 2	37.7	52.0	67.7	24.4	7.9
9. E. M. 1	37.5	32.7	56.9	21.7	21.4
33. J. F.	33.1	12.4*	51.6	24.5	23.9
2. P. L. 5	31.1	29.3	74.0	14.6	11.4
46. H. F.	25.2	53.7†	6.6	49.6	43.8
19. V. R.	19.8	30.8	45.2	No separation	
45. J. D.	15.3	57.1†	11.0	56.3	32.7
41. J. M.	10.6	14.4	34.2	34.3	31.5
20. N. K. 2	10.5	18.6	41.4	35.1	23.5
27. N. K. 1	7.0	27.3	27.5	55.8	16.7
47. C. V.	7.0	17.2	20.5	No separation	

* Stool contained considerable mucus. † Infant was very ill.

In the cases where the fat intake is high there is a somewhat higher per cent. of total fat in the stool and a higher proportion of the fat as soap than in the other cases with lower fat intake. The only marked exceptions to this are two instances in which a large proportion of the stool was mucus and two others in which the children were very ill. In general, the stools are more nearly normal when the fat intake is high. In other words, the normal condition in breast fed infants seems to be a high fat intake.

In eleven instances not only was a record of the exact daily fat intake obtained, but the stools were collected for definite periods, twenty-four or forty-eight hours. It is to be regretted that this number is so small, for there is need of more exact knowledge in regard to the absorption of fat by breast fed infants. Various investigators, Michel, Keller, Rubner and Heubner, Freund, Uffelmann, Nobécourt and Merklin, report figures for fat absorption ranging from 92 to 99 per cent. This range is similar to that found in our cases. Table 8 presents the findings in eight observations on six normal infants and shows a range in absorption from 90.3 to 99.2 per cent. of the fat intake, and an average of 95.1 per cent.

TABLE 8.—Absorption of Fat by Normal Breast Fed Infants

Case	Age	Intake, Gm. Fat Daily	Excretion, Gm. Fat in Feces Daily	Per Cent. of Intake Absorbed	Condition of Child
38. E. M. 2	12 wk.	42.5	0.31	99.2	Gaining
33. J. F.	10 mo.	33.0	0.27	99.2	Healthy, gaining; stool green and full of mucus
2. P. L. 5	9 wk.	31.1*	1.61	94.9	Excellent condition; gaining
4. P. L. 2	3 wk.	37.7	1.95	94.8	Excellent condition; gaining
6. P. L. 3	3.5 wk.	41.9	2.26	94.5	Excellent condition; gaining
41. J. M.	4 mo.	10.6	0.62	94.2	Gaining very little; mother's milk abnormally low in fat and sugar
19. V. R.	3 mo.	19.8	1.22	93.9	Well nourished but not gaining at time of observation
17. D. T.	6 wk.	9.8	0.94	90.3	Gaining; previously marasmus
Average.....	.....	.....	.....	95.1	

* 4.3 grams fat from small amount of formula.

In contrast to the foregoing, Table 9 shows how fat absorption is reduced under abnormal conditions. The three observations reported in this table were upon children acutely ill.

Attention should be called to the high intake in five of the cases in Table 8. With over 30 gm. of fat daily, all the children were gaining well and their subsequent progress was entirely satisfactory. An intake of 41.9 gm. of fat daily at the age of 3½ weeks, as in Observation 6, might be thought excessive, but this infant had stools entirely normal, and his condition was at the time, and continued to be, excellent.

The great loss of fat under abnormal intestinal conditions is shown by two of the observations in Table 9. One child, who was very sick with ileocolitis, but whose stools were not loose at the time, had a daily loss in the stool of 5.7 gm. of fat. Another child with severe diarrhea lost 12 gm. of fat daily in the stool.

TABLE 9.—Absorption of Fat by Sick Breast Fed Infants

Case	Age	Intake, Gm. Fat Daily	Excretion, Gm. Fat in Feces Daily	Per Cent. of Intake Absorbed	Condition of Child
47. C. V.	5.5 mo.	7.0	1.48	79.0	Not gaining; eczema and diarrhea; mother's milk very low in fat
45. J. D.	8 mo.	15.7	5.71	62.6	Ileocolitis
46. H. F.	6 mo.	25.2	12.00	52.5	Acute diarrhea

In the literature of the fat metabolism of infants emphasis is frequently laid on the point that a high proportion of fat and particularly of soap fat in the stools is to be looked on as unfavorable. This belief is apparently based on the assumption that the stools of healthy breast fed infants, taken as a normal standard, contain a low per cent. of fat, comparatively little of which is in the form of soap. The results obtained by us with so considerable a number of healthy breast fed infants are entirely at variance with this view.

CONCLUSIONS

1. The fat of the stools of normal breast fed infants, according to our observations, averaged 34.5 per cent. of the dried weight and frequently was as high as 50 per cent.

2. The soap fat in the best stools predominated over the other forms of fat, averaging 57.8 per cent. of the total fat, as determined on the dried stool. The average stool of the normal breast fed infants showed a soap fat of 43.1 per cent. of the total fat, as determined on the dried stool, which would correspond to over one-third of the total fat of the fresh stool.

3. The neutral fat in the best stools averaged 15.9 per cent. of the total fat; in the average stool the neutral fat was 20.2 per cent. of the total fat. The amount of neutral fat is not affected by the drying process.

4. No constant relation was shown between the per cent. of fat in the mother's milk and the per cent. of total fat and its distribution in the stool.

5. With a higher total intake of fat, the fat per cent. and the soap fat in the stool were somewhat increased.

6. A range of fat absorption from 90.3 to 99.2 per cent. of the intake was found in healthy breast fed infants.

We wish to acknowledge our thanks to the physicians of the New York Foundling Hospital and the Vanderbilt Clinic, and to the visiting physicians of the Babies' Hospital for their kind assistance in collecting stools.

A NUTRITION CLINIC IN A PUBLIC SCHOOL*

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Nutrition clinics conducted for a period of time in hospital work have shown that malnourished children recover health and strength almost in direct proportion to their home control. Where there is complete control of the patients during the whole twenty-four-hour period, as in a child-helping institution, recoveries may occur in nearly 100 per cent. of all cases.

The fact that malnutrition is due only in a minor degree to poverty, to inheritance, to tuberculosis, to syphilis or to other obscure diseases, but in the great majority of cases is due to adequate causes such as physical defects, improper food habits, overfatigue and errors of home and school life, makes the work of correcting malnutrition, though partly medical, for the greater part educational. Therefore, theoretically at least, such work should be carried on in the school, where health habits and practical hygiene can be taught as a part of the school program. Accordingly, an invitation from the Bureau of Educational Experiments of New York to conduct a nutrition clinic under its auspices in a public school in that city was welcomed as an opportunity to demonstrate whether it is practical during a school régime to secure a sufficient part of the essentials of health to obtain satisfactory results. These essentials for the health of the growing child are the removal of physical defects interfering with nutrition, inducing the child to take sufficient food at frequent intervals, obtaining good air day and night, preventing fatigue, and securing sufficient home control to insure good food and health habits.

Through the cooperation of the principal, permission was obtained to conduct the experiment in Public School 64, situated in the crowded East Side. The number of children in the school was about 3,000, more than 90 per cent. of whom were Hebrews. The work was carried on under circumstances that would have been almost prohibitive were it not for the enthusiastic support of the principal, Mr. Louis Marks, and his assistants. The treatment by the Class Method was conducted in one small room, the only available space, shared by the eye clinic, the school nurses, and workers who were making a

* The following personnel assisted in the work of the nutrition clinic, February to June, 1918: Medical work: Adolphus DeSanctis, M.D., Henry J. Schreiber, M.D. Nutrition work: Miss Mabel Skilton. Tables compiled by David Mitchell, Ph.D.

special survey. The children were scattered throughout the various rooms, as it was not practical to segregate the malnutrition group during the experiment nor relieve them from the pressure incident to their grade work necessary for promotion. Further difficulties existed in the fact that it was war year, one physician being obliged to leave the clinic just as the work was getting under way. Hospitals were so short of physicians that the work of removing physical defects, as diseased adenoids and tonsils, was much delayed and in large part undone. In this school building there was neither gymnasium nor hall where the floor could be used for rest periods. However, this need was met by the kind cooperation of Miss C. I. McColl of the Christodoro House nearby, who not only provided a room for rest periods, but also accommodation for the serving of lunches. The value of the experiment was greatly increased by the cooperation of the New York School Lunch Committee, which provided school lunches to various groups in order to test the effect of these lunches on nutrition.

The work was carried on locally by one physician who made first examinations and was present to help conduct the class exercises. The preparation for the class work was made by a social service worker and an assistant. Supervision of the entire work was obtained by weekly visits of the writer to the clinics and by a trained nutrition worker who spent a portion of her time at the clinics.

The conduct of the clinic was as follows:

Weighing and Measuring. — Eight hundred ninety-four children from various grades were weighed and measured without shoes, but with indoor clothing, and their percentage of underweight or overweight reckoned according to the average weights for heights computed by Boas and Burke.

The child who is chronically 7 per cent. underweight for his height is retarded practically one year in both weight and height. Such stunted children are not only undernourished, but malnourished. The weighing and measuring was for the purpose of identifying this group. Table 1 shows the number found to be of normal weight and the number 7 per cent. or more overweight or underweight for their height.

It will be seen from Table 1 that an average of 18 per cent. were underweight. Based on these figures, in New York City alone, with approximately one million school children, one hundred eighty thousand are probably malnourished. It is to be noticed that the percentage in the various groups showed no marked variation except in the groups marked "special" and "open-air." These specials include sixty-nine children examined by a psychologist and rated as excep-

tionally bright. As a rule, they came from families living in more comfortable circumstances than the other children. Their higher rate of malnutrition agrees with our experience, that malnutrition exists to a greater degree among the rich than among the poor. The open-air group consisted of twenty-five children who had found their way to the only open-air room in the building because of tuberculous history or because they were "anemic." It is interesting to note that the percentage of underweight of the specials was practically the same as that of the open-air group, which latter group was supposed to represent the twenty-five children from ten grades who most needed special care.

TABLE 1.—PERCENTAGE OF OVERWEIGHT AND UNDERWEIGHT CHILDREN

	Grade I	Grade V	Grade VI	Grade VII	Open-air	Specials	Total
Children 7% or more overweight:							
Number	27	21	40	38	1	7	134
Per cent.	10.6	16.5	16.3	22.0	4.0	10.1	15.0
From 7% overweight to 7% underweight:							
Number	185	79	166	110	17	43	600
Per cent.	72.5	62.2	67.8	63.6	68.0	62.4	67.0
Children 7% or more underweight:							
Number	43	27	39	25	7	19	160
Per cent.	16.9	21.3	15.9	14.4	28.0	27.5	18.0
Total number	255	127	245	173	25	69	894
Total per cent.	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Physical Examination.—The next step was a complete physical examination. This was made without clothing and according to a regular form[1] in order to save time and insure no omissions. At the end of the examination all physical defects were noted under "diagnosis" in order that steps might be taken promptly for their correction. The average number of defects found was five, the most important of which was nasopharyngeal obstruction.

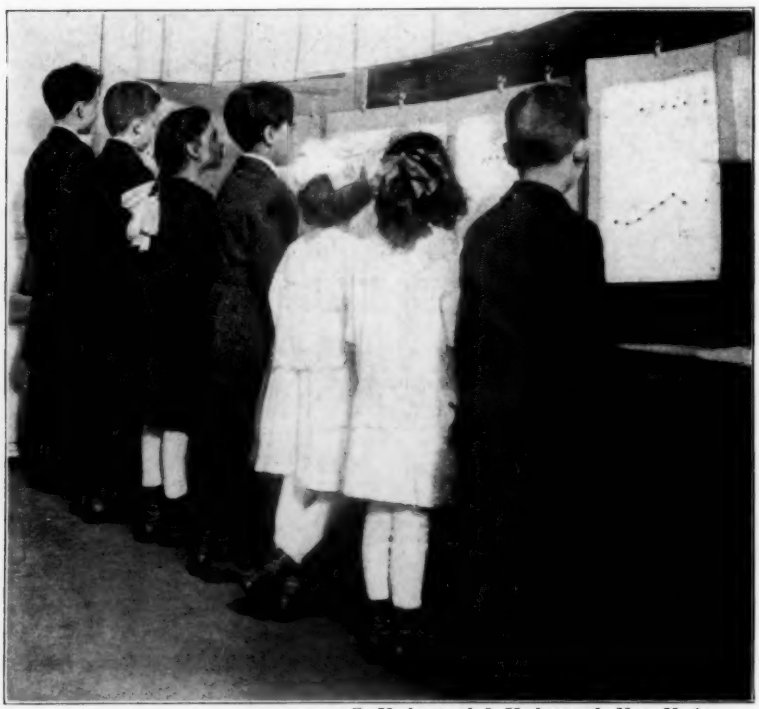
Treatment.—The children were given varying treatment in six groups for the purpose of comparing results.

Class Method: The child was weighed each week and his weight charted, his diet list for two days was kept and reckoned, and the child was placed in the class according to his gain or loss. Then the various probable reasons for gain or loss as they appeared in the most evident cases were discussed with the group, and suggestions made to help in the child's gain the following week. These suggestions had to do with the use of tea or coffee, food habits, the need of open windows, the avoidance of late hours and of overtire, and of such other causes

1. Emerson, William R. P.: Standardized Physical Examinations, Arch. Pediat., July, 1918.

as clearly prevented gain. Occasion was taken to encourage those who gained weight, and to make plain the cause in the case of those who lost weight. As each child saw his own chart and recognized the reason for gain or loss, his cooperation was obtained in every instance.

Rest Periods: A half hour was taken in the forenoon, lying on the floor wrapped in a blanket, and a similar one advised to be taken in the afternoon at home.



C. Underwood & Underwood, New York.

Fig. 1.—On the day of the nutrition class exercise, the children are eager to examine the charts to compare their gains. Their interest to know the cause of a loss or gain is remarkable—an ideal situation for effective instruction.

Diet Records: Each week the older children were asked to bring a two-day list[2] of all food taken. These lists were checked up on the day of the weighing and suggestions made to correct any serious fault of diet and also to encourage the use of cereals and milk. Otherwise interference with the home table was avoided so far as possible.

Lunches: A small lunch, from 250 to 300 calories, was supplied to certain groups in the midforenoon, and also a dinner of about 1,200 calories was provided to certain groups in the middle of the day.

2. Emerson, William R. P.: Record Book for Measured Feeding.

Home Visits: Each child's home was visited by the nutrition worker with the definite object of knowing the parents, of obtaining their cooperation in the work of getting their children to gain and of finding causes in the child's home life that prevented gain. Special attention was paid to the need of open windows at night and of taking sufficient time at meals.

The six groups were treated as follows:

Grade I.—Class Method; advised to take rest period and lunch.

Grade V.—Midday dinner only.

Grade VI.—Class Method; diet records; rest; lunch; midday dinner.

Grade VII.—Class Method: diet records; rest; lunch; no midday dinner.

C. Underwood & Underwood, New York.

Fig. 2.—Six of these children, five in the front row and the boy by the piano are taking their rest periods properly, lying flat on the back. The other six illustrate various improper positions. Many of these children fall asleep during the half-hour period of rest.

Specials.—Class Method; diet records; lunch; advised to take rest period.

Open-Air.—Instruction; diet records; rest; lunch.

An important object in this varied treatment was to observe the value of direct feeding compared with that of instruction in health habits.

Results by the Class Method.—The results for the four groups which had treatment by the Class Method are shown in Table 2.

TABLE 2.—Increase in Weight by Pounds and Percentages

Class	Grade I	Grade VI	Grade VII	Specials	Total
Total gain	55.7	109.0	72.0	61.6	298.3
Normal gain	40.5	89.9	64.8	43.2	238.4
Net gain	15.2	18.1	7.2	18.4	59.9
Percentage of gain in excess of normal	37.5	20.1	11.1	42.6	25.0

The total gain for the children in Grade I was 55.7 pounds. The expected[3] gain for the period during which the children were in the nutrition class (approximately nineteen weeks) was 40.5 pounds. The net gain made by the children was therefore 15.2 pounds. The percentage of gain in excess of normal is 37.5. The children in Grade VI for a similar length of time gained 109 pounds, which is 18.1 pounds more than the expected gain of 89.9 pounds for the period. The percentage of gain in excess of normal for Grade VI is 20.1. The children in Grade VII made a likewise satisfactory progress. Their total gain was 72 pounds as compared with an expected gain of 64.8. This leaves them with a net gain of 7.2 pounds, or a percentage of gain in excess of normal of 11.1. The total gain for the 17 "specials" was 61.6 pounds. Their expected gain was 43.2 pounds, giving a net gain of 18.4 pounds, or a percentage of gain in excess of normal of 42.6. Thus these children gained almost 50 per cent. more than the average expected gain.

The result for all these children who had treatment by the Class Method is shown in the final column. Their gain was 298.3 pounds, while the expected gain was 238.4. This made an excess of 59.9 pounds, or a percentage of gain in excess of normal of 25. In other words, these 94 children, to 62 of whom dinner was not provided, but all of whom were given instruction in health habits, and for some of whom certain physical defects were removed, gained 25 per cent. faster than was expected.

Results of Other Special Treatment.—Grade V, to whom dinner alone was provided, shows the poorest record. In this group twenty children were included in the beginning. At the end of the period fifteen of them were weighed the second time; the remaining five were not present for the second weighing. Their total gain for the period was 6 pounds. Their expected gain was 23.2 pounds. This means that the children of this grade to whom a sufficiently large midday meal was given, gained at only one quarter the normal rate. They were 74.1 per cent. behind what was expected of them.

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3. The expected gain is calculated in the following way: The average yearly increase as given in the table of normal weights is used as a basis and a proportional increase for the period of the nutrition classes calculated. The normal increase for a 12-year-old boy is 8 pounds. In the nineteen weeks he would be expected to gain approximately 3 pounds. A 15-year-old boy should gain 14 pounds in a year and in the nineteen weeks he would be expected to gain approximately 5 pounds. The expected gain thus refers to the normal or average increase for children of that particular age during the specified period.

The children of the open-air class made a total gain of 13.7 pounds, whereas their normal gain would be 23.2. They thus gained at only about one half the rate expected of them. For this condition there is an explanation in the fact that instruction was given them, while all the other children in the open-air class were in the room. The Class Method of instruction and the spirit of cooperation and competition could not well be worked. There was a constantly disturbing element in the presence of children who did not need and were not interested in the nutrition work.

The foregoing statement presents a report for all the children for the whole period of approximately nineteen weeks.

TABLE 3.—INCREASE IN WEIGHT BY POUNDS AND PERCENTAGES

Class	Grade V	Open-Air
Total gain	6.0	13.7
Normal gain	23.2	23.2
Net gain	—17.3	—9.5
Percentage of gain in excess of normal	—74.1	—40.9

In the first grade the children were only 6 years of age; the attendance of six of that age was unsatisfactory. In the sixth grade three boys were dismissed for misbehavior, three were transferred to the open-air class, and one joined the class very late in the season. In the seventh grade, also, two boys were dismissed for misbehavior. Of the specials, it was found impractical to retain two children who came in from another school; one girl was dismissed as a disorganizer, and one boy was registered but attended no class exercise. Toward the end of the school year, it was found necessary to transfer the classes from morning to afternoon because the room was needed for other purposes. Therefore, pupils had to be kept after school for nutrition work at a season of the year when they especially wished to be out of doors. Beginning in February and continuing throughout the nineteen weeks all children were weighed with indoor clothing, without shoes. It seemed impracticable to make allowances for the lighter clothing of May and June. However, slight changes in clothing represent an appreciable factor in dealing with percentages when the expected gain for the period is only 2 or 3 pounds. For these reasons, in addition to giving results for the whole group for the full period of nineteen weeks, the statement in Table 4 of the results of the first twelve weeks before changes in clothing were made, and when all classes were running smoothly, omitting the above mentioned nineteen children, gives perhaps a fairer view of results.

The specials and Grade I made the most rapid relative gain. These groups were, however, of different ages, and their reactions should be compared to the older groups in only a general way. Grades VI and VII were of the same age, and their conditions of treatment varied only in one respect, namely, that Grade VI had the noonday dinner at the school, while Grade VII did not — yet their rate of gain is practically the same.

TABLE 4.—INCREASE IN WEIGHT BY POUNDS AND PERCENTAGES *

	Grade I 20 Children, Av. Age 6	Grade VI 20 Children, Av. Age 12	Grade VII 21 Children, Av. Age 12	Specials 14 Children, Av. Age 10	Total
Total gain	47.6	51.4	58.1	54.2	217
Normal gain	19.8	37.0	38.8	19.4	115
Net gain	27.8	20.4	19.3	34.8	102
Percentage of gain in excess of normal	140.0	55.0	50.0	179.0	89

* Compiled by the writer from same data as the other tables.

In view of the fact that nasopharyngeal obstruction is such an important factor in rate of gain, a further comparison may be made by eliminating from these two groups those who questionably needed operation. The eight remaining in Grade VI gained at the rate of 166 per cent., while the nine remaining in Grade VII gained at the rate of 154 per cent. above the expected rate of gain — further evidence that the midday dinner taken at the school had little or no effect on the rate of gain.

Factors Causing Malnutrition.—Physical Defects: An average of more than five defects in each child was found in this group of 125 children. Certain of these defects, as those interfering with respiration, may be considered causes for malnutrition, and certain others, as postural defects, may be considered results of malnutrition. However, these results may in turn become causes. The two most frequent defects found were nasopharyngeal obstruction and carious teeth.

Adenoids and Tonsils: The effects of nasopharyngeal obstruction were apparent in 66 per cent. of these children. Whether nasopharyngeal obstruction continued to be a factor in the nutrition of the child could not be determined, but Chart 1 shows the relative gain, five weeks before operation and five weeks after operation, of the nineteen children who received surgical treatment. These two five-week periods were separated by at least a week, so that the child's weight should be the same at the beginning of the second five weeks as it was at the end of the first five.

The question as to the need of operation in doubtful cases was answered in many instances by the failure of the child to gain, or, on

the other hand, by his ability to make a good gain. In other words, the Class Method is a valuable clinical aid in the diagnosis of toxicity from inflammatory processes in the respiratory tract, whether due to obstruction or to septic infection.

Carious Teeth: Our results do not show a marked effect of carious teeth on the percentage of underweight. There were seventeen of our 105 children for whom no record was obtained, while of the remaining

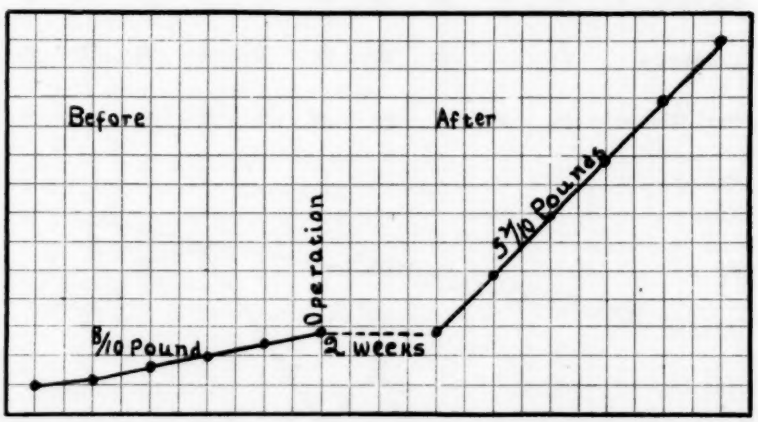

Fig. 3.—Adenoids and tonsils. Group of nineteen children showing average gain five weeks before and five weeks after tonsil and adenoid operation, allowing two weeks for recovery. P. S., 64, 1918.

eighty-eight children, twenty-five had no carious teeth; sixty-three, or 72 per cent., had from one to twelve carious teeth. The distribution of the children with the average percentage of underweight is shown in Table 5.

TABLE 5.—Distribution of Underweight Children

No carious teeth.....	0	1	2	3	4	5	6	7	8	9	10	11	12	No record
No. of children.....	25	21	12	9	8	3	3	2	2	1	1	0	1	17
Av. % underweight.....	10	9	8	13	9	10	10	16	10	13	9	0	13	10

It is to be noted that those children with five or six carious teeth were on the average 10 per cent. underweight, while one child who had twelve carious teeth was only 13 per cent. underweight. Twenty-five children had sound teeth; they were 10 per cent. underweight. Twenty-one children had one carious tooth; their average was 9 per cent. underweight. It is significant that the average per cent. underweight of these children with and without carious teeth remains approximately constant.

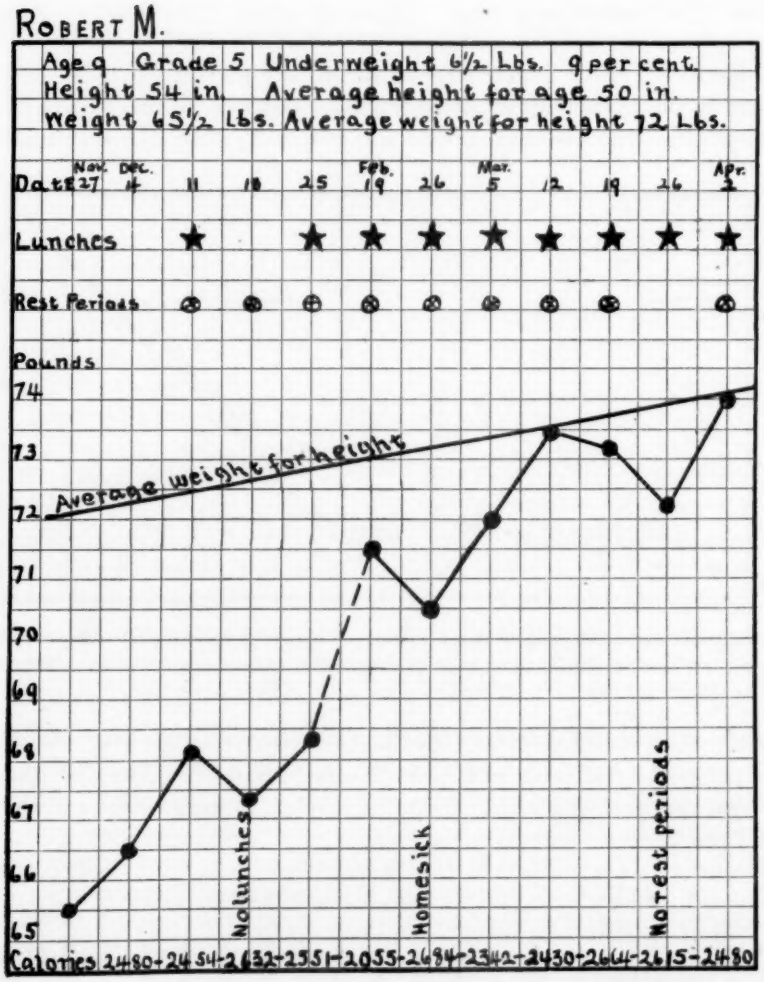

Fig. 4.—Specimen chart kept for each child under treatment by the class method. Red star represented by * means daily lunch; blue star represented by ⊛ means daily rest period; gold star, represented by ● means greatest gain in week. The weight curve is that of a child, not in this group, chosen because he was under constant observation day and night together with eleven other children, all of whom lost weight on these same dates when lunches and rest periods were omitted the week preceding. On the original chart the weight curve is in red. Diagnosis of the cause of gain or loss in weight of children in the school group could be made by inference only, and therefore could not be verified.

These observations agree with those reported in a previous article,[4] where a group of 100 so-called well children showed 64 per cent. having carious teeth. However, excluding two with alveolar abscesses, twenty-two of these children who had severe malnutrition showed exactly the same percentage as the whole group, namely, 64 per cent. Both observations suggest that there may be faulty conditions of the teeth, but unless the carious processes affect the chewing surfaces or cause alveolar abscesses, there may not be sufficient production of toxins to interfere with nutrition.

Faulty Health Habits: The most frequent were:

1. The use of tea and coffee.
2. The omission of milk and cereals from the diet.
3. Fast eating and irregular meals.
4. The use of sweets between meals.
5. Sleeping with closed windows.
6. Overfatigue.
7. Late hours.
8. Too little time spent in the open air.
9. Irregular living due to lack of home control.

Power of the Class Method.—The Class Method appeals to the imagination of the child and makes him do for himself what no one else can do for him. It teaches and inspires him to "train for health" in the same way he trains to be a Scout or a good athlete. Therefore, ask him what you will, he will do it cheerfully if he is convinced it is good. The boy of 7 or 8 years steals off by himself, wraps himself in his blanket and takes his rest periods, or teaches himself to take and to like foods to which previously he had an aversion. He stops tea or coffee, goes to bed early, prepares his bed with hot water jug and papers between blankets, that he may sleep with his windows open on the coldest night. All this he does that he may get his star each week and see his weight go up. Two of these boys were heard to greet one another in the morning as follows: "How are you, Sam, this morning?" "Gaining, thank you." Another boy was told he could not be well and strong until his adenoids and tonsils were removed. He immediately secured permission for an operation from reluctant parents, went to the hospital alone and appeared in the school next day, feeling light headed and in some pain, but the operation had been performed. A parent who chanced to be a physician sent word to the clinic: "How do you get my boy and girl to do of their own accord the very things that I have not been able to get them to do, although I have tried for

4. Emerson, William R. P.: A Group Study of the Results of 100 Physical and Mental Examinations of So-Called Well Children, Internat. Clinics **2**: Series 27.

years." The children took their lunches and kept their rest periods holidays and Sundays. One boy planned his diet during Passover week in such a manner that he kept up his twenty-four-hour amount (calories) and continued to gain.

CONCLUSIONS

1. All children at the beginning of the school year should be weighed and measured, and once a month thereafter during the school year, that their condition and rate of growth may be known.

2. Parents and teachers of all children 7 per cent. or more underweight should be notified of their condition, that they may be given special observation and obvious causes for their malnutrition removed.

3. Malnourished children, especially, need a complete physical examination made in the presence of their parents, that the average of five or more physical defects, particularly those interfering with breathing, may be corrected and the children be made free to gain under proper hygienic conditions. Such complete examinations are welcomed by parents.

4. Malnutrition is not accurately diagnosed either by superficial school inspection or by the stethoscope.

5. Children 7 per cent. or more underweight should be grouped in open-air classes, school pressure removed, and the Class Method used in treatment as a part of the school program. The severest cases of malnutrition may be treated first, and so on until all cases are eliminated.

6. Rest periods in the midforenoon are necessary, especially where the school has one session. Rest should be taken lying down on the back with the windows open, blankets being provided for protection and warmth.

7. School lunches should be available. They should be served hot, and the serving should in itself be a practical means of education.

8. Provision of food is not in itself adequate to solve the problem of malnutrition.

9. Carious teeth do not necessarily cause malnutrition.

10. Each child should have his twenty-four-hour amount of food measured for two successive days each week, that his food habits may be known and if necessary corrected.

11. The Class Method of treating malnutrition is sound pedagogy. It is an effective method of teaching practical hygiene and the essentials of health. It represents an economy of time and energy for teacher, school nurse and administration. It is based on the principle of a "sound mind in a sound body," and that it is poor judgment to rate

school efficiency on the amount of pressure that can be brought to bear on these already overburdened children in order that they may be made to graduate with their class and thus maintain a perfect school score.

12. There is no evidence in the weighing and measuring of these children that malnutrition, if left untreated, tends on the whole to correct itself. The percentage of malnutrition for the older children is no less than that for the young children. It is, then, fair to assume that the nation's list of physically unfit is supplied by this group of malnutrition children in the schools. Its percentage is about the same as has appeared in the Students' Army Training Corps and recruits for the army rated as physically unfit. The school system should not by its disregard of the physical condition of its children increase malnutrition. By weighing and measuring at regular intervals, by securing careful physical examinations, by teaching proper food habits and other essentials of health, it should graduate its children physically as well as mentally fit, thus eliminating malnutrition as an unnecessary element of national weakness.

BOVINE TUBERCULOSIS IN CHILDREN

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The purpose of this article is to present an analysis of twenty-four cases of tuberculosis in children and infants, with special reference to the bovine or human type of infecting organism in each case.

The results of most investigations into the occurrence of the bovine type of the tubercle bacillus in tuberculosis of children tend to demonstrate the importance of this organism in cases appearing in the early years of life, despite the authoritative opinion expressed by Koch in 1901. It seems to be the general opinion that the bovine type of bacillus is not so likely to be the one found in cases distinctly pulmonary in character as in cases of abdominal, meningeal or bone and joint tuberculosis; as to the rôle played by the bovine organism in tuberculous adenitis opinions vary. The two largest reliable collections of cases in which the types of tubercle bacilli have been determined are contained in a tabulation of 545 cases made by Park and Krumwiede[1] in 1912 and in a report by A. S. Griffith[2] in 1917, summarizing the cases worked out by the British Commission, together with cases since reported by the same men using the same methods, in all 588 cases of children up to 16 years of age. The tables of Park and Krumwiede, made up of their own cases and of cases from other sources, including those of British and German investigators, show the occurrence of the bovine type of organism in 21 per cent. of 368 cases of tuberculosis of all kinds in children under 5 years of age, and in 26 per cent. of 177 cases in children from 5 to 16 years old. In both groups over half or nearly half of the cases of tuberculous adenitis, abdominal tuberculosis and generalized tuberculosis of alimentary origin yielded the bovine type of tubercle bacilli. In some contrast to these percentages are those shown in Griffith's report, which also includes material from different kinds of tuberculous lesions, the bovine type of bacillus being found in 34 per cent. of 196 cases falling within the younger age period, and in 22 per cent. of 392 cases of older children up to 16 years of age. In connection with this British report it is to be noted that several Scotch investigators have found a high incidence of bovine infection in Edinburgh in tuberculous chil-

1. Park, W. H., and Krumwiede, C., Jr.: J. M. Res. **27**:109, 1912.
2. Griffith, A. S.: Brit. J. Tuberc. **11**:160, 1917.

dren (A. P. Mitchell,[3] 65 out of 72 cases of cervical adenitis; J. Fraser,[4] 62 out of 100 cases of bone tuberculosis; C. Y. Wang,[5] 11 out of 20 cases of different varieties of tuberculosis). The proportion of bovine infections in tuberculosis of children in England, in Germany and in this country is apparently smaller than in Edinburgh.

The twenty-four cases of tuberculosis comprising the basis of the study here presented include infants and children ranging in age from 2½ months to 11 years. All but three cases had a fatal termination, necropsies being obtained on fourteen, although two of these postmortem examinations had to be limited to the head. An attempt was made in each case coming to necropsy to determine the primary focus of infection, the lesion appearing to be the oldest after thorough search and histologic study being the criterion. It is not always easy to determine the primary focus. Wollstein and Bartlett,[6] in an analysis of 178 postmortem examinations in infants and young children, were unable to determine the primary focus in thirteen cases; in an earlier report Wollstein[7] says that in the majority of cases of extensive generalized tuberculosis in the young child no certain primary lesion can be demonstrated. This author agrees with the dictum of Ghon[8] that in children the primary infection of the lung is the usual mode of infection, and that the great majority of cases of tuberculosis are of inhalation origin. In this connection it should be remembered, as pointed out by Ravenel,[9] that the oldest lesion may not indicate the portal of entry, since it has been shown that animals fed with tubercle bacilli sometimes present the primary focus in the lung.

Determination of the bovine or human type of bacillus in each of the cases making up the present study has been based on the result of inoculations of rabbits with known amounts of cultures. The growth of cultures on agar containing 5 per cent. of glycerin has given some indication as to the probable type of organism, but, while strains ultimately found to be bovine have always grown scantily on this medium, some of the human strains have needed several transplantings on glycerin-agar before producing the typical relatively luxuriant growths. The sources of the cultures used for inoculations have been various, dependent on the site of infection. Frequently better growths have been obtained after passage through guinea-pigs than when cultures have been made direct from necropsy or bacteri-

3. Mitchell, A. P.: Brit. M. J. **1**:125, 1914.
4. Fraser, J.: Brit. M. J. **1**:760, 1913.
5. Wang, C. Y.: Edinburgh M. J. **18**:178, 1917.
6. Wollstein, M., and Bartlett, F. H.: Am. J. Dis. Child. **8**:362, 1914.
7. Wollstein, M.: Arch. Int. Med. **3**:221, 1909.
8. Ghon, A.: Der primäre lungenherd bei der Tuberkulose der Kinde.
9. Ravenel, M. P.: Arch. Pediat. **34**:137, 1917.

ologic material. Dorset egg medium, prepared with aseptic precautions and not sterilized after inspissation, has usually been found satisfactory for obtaining first growths and also for routine transplants; in one case, however, Petroff's medium yielded an initial growth when the Dorset egg medium failed. All cultures were tested on glycerin-agar; as noted, this frequently gives an indication as to the probable type of organism, especially if the growth is luxuriant. Except for six animals inoculated with glycerin-agar growths, the rabbits all received inoculations from growths on egg medium. The ages of the cultures when used ranged from eight to twenty-one days, an occasional culture being a few days older. The generations of these cultures varied from the third to the ninth, representing a total duration of cultivation of from 21 to 372 days, three cultures having a total duration over 400 days. Subcutaneous inoculation between the shoulders was made in all cases, a method found to prove satisfactory in the hands of the investigators of the British Commission,[10] both in their work at that time and in their various investigations since then. The dose in most of the animals was 10 mg. of culture suspended in physiologic sodium chlorid solution. This amount of culture was usually obtained by direct weighing of the growth carefully taken off from the medium, followed by suspension in salt solution of known amount and subsequent division of this suspension to obtain the desired dose. In some cases, with scanty growths, the dosage estimation method of the British Commission[10] was used.

Two rabbits, controlling each other, were inoculated in every bovine case; in all but one of these cases both animals died in from 47 to 91 days and presented at necropsy generally disseminated tuberculosis, always well marked and involving the lungs extensively. In the one other case the first rabbit inoculated died 105 days after inoculation without very extensive lesions as compared with other bovine rabbits; two other rabbits, however, receiving transplants from the same culture both gave typical bovine results (Case 12). It was also characteristic of rabbits inoculated with the bovine type of bacillus to show a marked loss in weight, from 200 to 900 gm. by the time of death. Rabbits weighing from 1,300 to 3,000 gm. were used in this series, most of the animals being within 200 or 300 gm. of 2,000, the lightest being used for strains of bacilli suspected of being human in type, the heaviest ones for bovine strains. The second rabbit in some cases received a different sized dose of culture from that of the first rabbit; in bovine cases, as indicated by the results in the first rabbit, this dose was smaller, in human cases larger, than 10 mg. Two rabbits were also used in the cases with the human type of organism, except

10. Royal Commission on Tuberculosis, Final Report, 1911.

in five instances, in each of which the cultural growths and the results of inoculation of one rabbit pointed with scarce a doubt to the human character of the infecting bacillus. The rabbits inoculated with the human type of organism lived for over a hundred days and presented when necropsied no generalized lesions, rarely any visible lesion beyond the site of inoculation, the local glands and the lungs, and in the latter organs the tuberculous process was never extensive. These animals lost very little or no weight, and many gained considerable. Two human type rabbits died before 100 days, 91 and 96 days, respectively, but both showed acute infection with other bacteria and the tuberculosis in each was strictly limited. Smears from rabbit lesions at necropsy almost always revealed more bacilli in bovine type than in human type infections. Cultures from rabbit lesions presented the same characters of growth in each case as the cultures used for inoculation.

TABLE 1.—SUMMARY OF CLINICAL AND POSTMORTEM FINDINGS

No.	Age	Clinical Tuberculosis Findings	Postmortem Tuberculous Lesions
Human Type of Bacillus			
3	2½ mos.	Generalized	Completely generalized
4	12 mos.	Generalized	Lungs, bronchial nodes, spleen, liver, peritoneum
5	12 mos.	Pulmonary	Lungs, bronchial nodes, pleura
2	15 mos.	Generalized	Right lung and pleura, bronchial nodes, intestines, mesenteric nodes
16	16 mos.	Generalized	Completely generalized
1	19 mos.	Pulmonary; meningitis	Left lung, bronchial nodes, spleen, pia
14	20 mos.	Meningitis	Lungs, bronchial nodes, spleen, liver, kidneys, peritoneum, pia
22	21 mos.	Generalized, and knee-joint	Completely generalized, and knee-joint
15	3½ yrs.	Meningitis	Bronchial nodes, spleen, pia (no lung lesions)
20	6 yrs.	Meningitis	Pia (necropsy of head only)
13	9 yrs.	Meningitis; hip-joint	Lungs, pleura, intestines, spleen, liver, kidneys, peritoneum, pia, hip-joint
21	2 yrs.	Pulmonary; meningitis	Died; no necropsy
24	4 yrs.	Meningitis; hip-joint	Died; no necropsy
6	5½ yrs.	Meningitis	Died; no necropsy
9	6 yrs.	Knee-joint; spine	Died; no necropsy
10	9½ yrs.	Meningitis	Died; no necropsy
17	11 yrs.	Spine, hip, knees, ribs, thumb and lungs	Living
Bovine Type of Bacillus			
18	8 mos.	Meningitis	Pia (necropsy of head only)
19	27 mos.	Generalized	Completely generalized
23	3 yrs.	Pulmonary	Lungs, bronchial nodes, spleen, liver
8	2½ yrs.	Two fingers of each hand; leg abscess	Living
12	3 yrs.	Hip-joint; thigh abscess	Living
11	4 yrs.	Pulmonary; meningitis	Died; no necropsy
7	5½ yrs.	Peritonitis (operation)	Died; no necropsy

Each rabbit received a corneal scratch into which was rubbed a drop of the bacilli suspension used for inoculating the animal, the other cornea being similarly scratched and rubbed simply with saline solution as a control. The control scratch in all cases and the test scratch in all rabbits with human type infection never showed more than a slight transient inflammatory reaction. Of the fifteen rabbits

with bovine type infection all but three presented marked persistent inflammation about the corneal scratch into which the bacilli suspension had been rubbed; the other three bovine type rabbits showed no more change in the test scratch than did human type animals.

Table 1 summarizes the more pertinent clinical and postmortem findings in this series of cases.

TABLE 2.—PRIMARY FOCUS AND SOURCE OF CULTURES

Number	Primary Focus	Source of Cultures for Inoculation
3	Left lung, base	Mesenteric nodes
4	Right lung, middle lobe	Bronchial nodes
5	Right lung, middle lobe	Lung
2	Right lung, apex	Bronchial nodes
16	Bronchial nodes, right (?)	Bronchial nodes
1	Left lung, upper lobe	Bronchial nodes
14	Right lung, middle lobe	Spinal fluid
22	Right lung, middle lobe	Lung
15	Bronchial nodes, right (?)	Bronchial nodes
20		Pia exudate
13	Right lung, upper lobe	Spinal fluid
21		Spinal fluid
24		Spinal fluid
8		Spinal fluid
9		Knee-joint pus
10		Spinal fluid
17		Hip sinus pus
18		Spinal fluid
19	Intestine	Bronchial nodes
23	Bronchial nodes, right (?)	Lung
8		Leg abscess, fluid
12		Hip-joint pus
11		Spinal fluid
7		Peritoneal fluid

In Table 1 "Clinical Tuberculosis Findings" include diagnoses of tuberculosis made during life. The term "Completely generalized," used under "Post Mortem Lesions," indicates involvement of the following: lungs, bronchial nodes, pleura, intestine, mesenteric nodes, spleen, liver, peritoneum and usually the kidneys.

The table shows seven of the twenty-four patients to be infected with the bovine type of the tubercle bacillus. In this series of cases it is not possible to draw any deductions as to the relative virulence of the two types of organisms, all but three of the cases being fatal (one of human type and two bovine type cases, without fatal termination to date, are all cases of bone or joint tuberculosis apparently localized). There is also little indication here regarding higher or lower percentage of bovine infection at different age periods; it so happens that but one out of nine patients under 2 years of age showed a bovine infection, and all seven of the bovine type patients were under 6 years. Park and Krumwiede[11] stated that up to 10 per cent. of deaths in young children are caused by the bovine type of organism; also a large percentage of the rarer alimentary tuberculosis requiring operation or causing death. Concerning the latter portion of this statement, it will

11. Park, W. H., and Krumwiede, C., Jr.: J. M. Res. **25**:313, 1911.

be seen in the table that the few cases in which an alimentary origin is probable have the bovine type of bacillus as the infecting agent.

In the twelve cases in which the primary focus is noted (Table 2), it was found in six in the right lung, in two in the left lung, in three cases apparently in a bronchial lymph nodule on the right side, and in one case in the intestine. One of the bronchial node cases and the intestine case had bovine infections.

The corneal scratch test was not very satisfactory. Although consistently negative in rabbits with human type infection, it was not always positive in the bovine type animals. If perfected, however, this test would be simple and convenient compared to other methods of test inoculation.

A word should be added in regard to infection through cow's milk, it being generally considered that bovine infection is most likely to occur in this way. Notwithstanding that all milk sold in Chicago is supposed to be pasteurized, yet here are seven cases of bovine infection out of twenty-four cases of tuberculosis in children. This fact points to the necessity of home pasteurization of cow's milk.

Although the series of cases here presented is too limited in number to permit of definite conclusions concerning the incidence of bovine tuberculosis in children as regards age, site of lesion and fatal outcome, it remains that finding seven out of twenty-four cases to be caused by the bovine type of organism emphasizes the importance of this variety of the tubercle bacillus in tuberculosis of children.

STUDIES IN THE NEPHRITIS OF CHILDREN

CLINICAL CONSIDERATIONS OF CLASSIFICATION, ETIOLOGY, PROGNOSIS AND TREATMENT *

LEWIS WEBB HILL, M.D.
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SECOND PAPER

I.

Nephritis in children is a common condition, much more so than is generally believed. During the last two years and a half there have been in the wards of the Children's Hospital nearly a hundred cases of acute and of chronic nephritis, and the following clinical study is based on seventy-five of these cases. Renal function tests as applied to children were discussed in a previous article.[1]

II. CLASSIFICATION

From the viewpoint of the practical clinician there has never been a satisfactory classification of nephritis. In the earlier days of the study of nephritis the classification was entirely pathologic, and was based on the end results of the morbid process as seen under the microscope. This was satisfactory enough from a pathologic point of view, but not from a clinical, as it was often difficult or impossible to tell from the clinical condition of the patient what the microscopic appearance of the kidney in question was, and hence into what group the patient should be put. The anatomic classification has another disadvantage in that in a large number of cases the kidney shows mixed types of injuries and cannot be put definitely into any one group. In a complicated structure like the kidney, which is made up of several very closely interrelated units (glomeruli, tubules, vessels), it is quite impossible for injury to occur to one group of structures without damage to the other groups as well. Again, as Dr. Christian has aptly said, the pathologist is studying the end-results of morbid processes, while the man who has to take care of the patient is more interested in the condition of the kidney at the time than in its appearance after death; also it is more vital to him to consider the kidney in its relation to the general condition of the patient than it is for him to be able to visualize its microscopic appearance. Moreover, a given kidney in the course of months or years may pass through several different classes of the pathologic grouping, according to how the damage is progressing.

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* From the Medical Service of the Children's Hospital.

1. Am. J. Dis. Child. **14**:267, 1917.

It can be seen from these few suggestions that there are many objections to the pathologic classification as a working basis.

It has also been attempted to classify nephritis on a functional basis, according to the power of the kidney to perform its various chemical activities. This conception originated with Widal and his co-workers some ten or twelve years ago, when students of nephritis were beginning to be more interested in what the kidney could do when the patient was alive than what it looked like after he was dead, and has been a most important stimulus to much valuable work on kidney function. The French school recognized three types; the type with nitrogen retention, that with salt retention and that with retention of both. It is undoubtedly true that almost pure types of salt or of nitrogen retention do occur, and that in a general way certain clinical appearances go along with these different types. This classification is at fault, however, in that it is not practical for the clinician, because in most cases he has not the time or the facilities for studying carefully the power of the kidney to excrete salt and nitrogen, and if he does have the time he is likely to find that the mixed types prevail.

As we have learned more about the problem of nephritis we have realized that if we have too complicated a classification it is not practical for most of us to follow, and we are beginning to believe now that a simple *clinical* classification is the most satisfactory. The problem in the child is somewhat different from that in the adult, because in children we do not ordinarily have to consider the "cardio-renal" cases, which form such an important group in the study of nephritis in the adult, and in which it is often hard to tell whether the vascular or the renal condition is primary, and which of the two is of the most importance in the general picture.

These considerations will serve for a justification of the simple clinical classification of nephritis which I believe is the best to follow. This does not take into consideration such conditions as syphilis of the kidney, ankyloid kidney, nephritis due to metallic poisons, etc., which are quite distinct from the ordinary types of nephritis seen, and which should have their own special places in any classification.

The cases of nephritis that we have studied at the Children's Hospital may be divided as follows:

	Cases
1. Acute hemorrhagic	25
2. Acute "Exudative"	24
3. Subacute	4
4. Chronic (ordinary type)	21
5. Chronic with infantilism (very rare)	1

1. *Acute Hemorrhagic Nephritis.*—By this I mean a nephritis the chief characteristic of which is a very bloody urine. This urine contains a moderate amount of albumin, usually considerable numbers of

pus cells, and round kidney cells, and *very few casts*. Sometimes the casts may be entirely lacking in one or two urine specimens, and observers who are not familiar with children may find it hard to believe that the condition is one of nephritis, and search for some other conditions, such as renal or ureteral stone, to account for the bloody urine. In some cases there may be very large numbers of round cells in the urine, nearly as numerous as the blood cells.

The child ordinarily does not seem very sick, there is usually no edema, but occasionally there may be a little. The blood pressure may be slightly elevated, but rarely markedly so, and the heart is of normal size. The kidney is usually able to handle water well, and there is therefore a good urinary secretion. There is very little tendency to uremia, and the prognosis is good. The process tends toward recovery, although occasionally chronic nephritis may develop. It is rare for the case to terminate fatally during the acute stage. Occasionally the urine may contain a few red blood cells and casts for many months and then finally become normal, and continue so. The various functional tests ordinarily show a moderate diminution of the kidney's functional capacity. This is the most common form of nephritis seen in childhood, and is especially likely to follow tonsillitis.

2. *Acute Exudate with Oliguria.* — So-called on account of the occurrence of edema. The edema may be moderate or excessive, and there is a wide difference clinically between the mild and the severe cases. In the mild cases the urine is somewhat diminished in amount, shows a moderate test for albumin, moderate numbers of blood cells, and many casts. The urine may sometimes contain a good deal of blood, but never as much as the pure "hemorrhagic" cases previously described. Also, in the exudative group there is always oliguria at some time during the course of the disease (usually at the onset), and the urine contains large numbers of casts, differing thus from the "hemorrhagic" type. The blood pressure is almost always moderately elevated, the functional tests are diminished, but the patient tends toward recovery. The severe cases present more the adult type of acute nephritis that has been described in the older textbooks. There is a large amount of edema, the urine excretion is very scanty, sometimes only 3 or 4 ounces a day over a period of several days. The oliguria is often followed by polyuria, during the stage of repair. The urine contains a large amount of albumin, a good deal of blood, and many granular, cellular and bloody casts. The blood pressure is often markedly elevated (130 to 150), which, of course, is not high for an adult, but is for a child. There is, coincident with the edema, an inability on the part of the kidney to excrete salt, and in the few cases in which we have examined the blood for retained nonprotein

nitrogen, we have found this to be high. Uremic symptoms are likely to occur, and the patient may die. If he does not die during the acute attack he is likely to recover entirely without the development of chronic nephritis.

3. *Subacute.*—The subacute cases are not common, but are seen occasionally, usually following an acute case of the hemorrhagic type. Instead of clearing up when it should (six weeks to two months) the urine may show small amounts of albumin and a few red cells microscopically for several months or even for as long as a year. The process is usually mild, and the patient feels well and seems well in every way. The blood pressure is not elevated, and functional tests show that the functional capacity of the kidney is little if any damaged. Some of these cases, I believe, ultimately develop a chronic nephritis, but the majority gradually clear up.

4. *Chronic Nephritis (Ordinary Type).*—Chronic nephritis may vary a good deal in the clinical picture which it presents, and for this reason some authors have recognized several distinct types, but I believe it best to group all of the more common types of chronic nephritis together, and to realize that in most cases the variations in clinical picture which any group of cases may present are dependent on different stages or phases of much the same process, or that they represent different degrees of destruction of the kidney substance. It is often surprising to see how mild some cases of chronic nephritis in children may be. The process may have existed for several years, and the child in some cases may look and seem perfectly well in every way. Physical examination discloses very little, except perhaps slight anemia. The blood pressure is normal, the heart is not enlarged, and one would never suspect that the patient had nephritis if it were not for the urine examination. The urine shows a moderate amount of albumin, and an occasional cast in most of these mild cases, although sometimes there may be acute exacerbations, with the occurrence of a considerable amount of blood. During these acute exacerbations there may be moderate edema. The functional tests are in many cases practically normal, and in a few show moderate impairment of function.

In the more severe cases the picture is that of the adult type of "chronic diffuse nephritis." These children are anemic, often markedly so, and show the characteristic facies, and the pale waxy skin seen in the adult. There is likely to be a good deal of edema, and a rather scanty secretion of urine, with the presence of a very large amount of albumin, many casts, some of which are waxy and fatty, and often a few blood cells. The blood pressure may be increased or may not be, and in a few cases there may be moderate cardiac hypertrophy, but not so constant or so marked as in adults. The func-

tional tests show a severely damaged kidney, and uremia is not at all uncommon.

5. *Chronic Nephritis with Infantilism.*—This is a very rare condition,[2] and may be likened to "chronic interstitial" nephritis in the adult. The condition develops insidiously, and is of unknown etiology. It sometimes occurs in several members of the same family. One interesting point in symptomatology is that these children usually show infantilism, a child of 10 or 12 years being developed mentally and physically only as much as perhaps a normal child of 5 or 6. The patient is subject to headache, the vision is poor, and there is often a marked albuminuric retinitis. The blood pressure is very high, often over 200, and the heart may show considerable hypertrophy. The urine is large in amount, and of low specific gravity. It contains usually a very small amount of albumin and an occasional cast. The functional tests are low, and the kidneys at necropsy are of the usual contracted type seen in the corresponding condition in adults. The prognosis is bad. In order to make more clear these various types of nephritis, later are given histories of representative cases from each group, from our records.

REPORT OF CASES

CASE 1. *Acute Hemorrhagic.*—A. H., 8 years old, two weeks before admission to the hospital had a sore throat. The tonsils were much enlarged, showed white spots, and there was considerable prostration and fever. He stayed in bed three or four days with this, the throat cleared up, and he got out of bed feeling well. A day or two later his mother noticed that his urine was bloody, and that his face was puffy, and brought him to the hospital for treatment. Physical examination at entrance was entirely negative, save for very large, ragged tonsils and slight puffiness under the eyes. There was no edema elsewhere. The urine was bright red in color, and showed a large trace of albumin, with large numbers of red cells, a few pus cells, and a very rare granular cast.

He remained in the hospital about six weeks. The only symptom he had was a certain amount of discomfort on micturition. The urine gradually cleared, and on discharge contained only a small amount of albumin and a rare blood cell. The amount of urine excreted daily during his stay in the hospital was good, and he never had any edema other than slight puffiness under the eyes. His mother was written to several months afterward, and replied that his urine was perfectly normal (examined by family physician) and that he was apparently in excellent health.

CASE 2. *Acute Exudative (of Moderate Severity).*—G. E., 4 years old. Ten days prior to admission her mother noticed that her legs, feet and arms were swollen; also that the abdomen seemed full and distended. For some time prior to this she had noticed a slight puffiness under the child's eyes in the morning, but paid no attention to it until the other parts began to swell. Physical examination showed a child with large tonsils and considerable edema of the face and legs; otherwise negative. The urine was "smoky," and contained a large trace of albumin, moderate numbers of red blood cells and many granular casts. The urine excretion was very scanty for a few days,

2. Between twenty and thirty cases have been reported in the literature.

and there was considerable gain in weight during this period. Gradually, under purgation and restriction of fluid intake her urine excretion increased and her edema disappeared. She never had any signs of uremia, and was discharged well about two months after entrance.

CASE 3. *Subacute.*—L. B., aged 12 years, entered the hospital Aug 14, 1915. She had been subject to frequent colds and sore throats for several years, and two years ago had her tonsils removed. About two weeks before Christmas (1914) she had a severe cold and sore throat. December 24 she complained of headache, and her parents noticed that her feet were swollen. She vomited a good deal, and seemed fairly sick. The family physician was called, examined the urine, said it contained blood, and that she had "acute kidney trouble." He kept her in bed for several weeks under careful treatment, and the amount of blood diminished considerably, but improvement was so gradual that after an attack of sore throat two months previously her physician advised another tonsillectomy, which was performed five days prior to the preparation of this report. She entered the hospital for an opinion of her present condition (original nephritis eight months previously). Clinically the girl seemed perfectly well. Her blood pressure was normal, she had no edema, and functional tests revealed no functional incapacity on the part of the kidney. Without a urine examination one would not have been suspicious that there was anything the matter with her. Her urine contained a very slight trace of albumin, with a few red blood cells and granular casts in the sediment. The phenolsulphonephthalein test was 66 per cent. (low normal for a child) and her nitrogen and salt excretion were normal (added salt and urea tests). She was discharged from the hospital with a guarded prognosis, and has unfortunately been lost track of since. The whole question in a subacute case such as this, is, of course, one of *prognosis.* Is the kidney going to recover entirely, or is a permanent and progressive chronic nephritis going to develop? In most cases I believe it is impossible to say; time alone can tell, although a marked lowering of the renal function tests is reasonably good evidence in favor of the development of a chronic process.

CASE 4. *Mild Chronic (with Acute Exacerbations).*—Isabella C., 9½ years old, was admitted July 26, 1915. One year ago she had a severe attack of tonsillitis, and was sick in bed for four or five days with it. At the end of this time she got up, apparently well, and remained well for two months, when her mother noticed that her urine was bloody, and that she had a little fever. This lasted only a day or two. Since this time she has had two similar attacks; the last one two weeks ago. Her mother is quite sure that the urine has been bloody during these attacks, and thinks that the child's face has been a little puffy also. She has never had any edema of the legs. An attack lasts usually only two or three days, and between attacks she seems perfectly well. Her tonsils were removed about a month ago.

At entrance the child appeared moderately sick; the physical examination was entirely negative; there was no edema. Her blood pressure was normal. The urine showed a slight trace of albumin, and the sediment contained a few red blood cells, hyaline and granular casts. Her phenolsulphonephthalein test was 70 per cent. She remained in the hospital several weeks and was discharged in general good condition, the urine showing about the same picture that it did at entrance. She has been seen several times since discharge, the last time on Nov. 17, 1917; over these years after the onset of the nephritis she has seemed always perfectly well, but her urine has at every examination contained a very slight trace to a slight trace of albumin, with a few casts on several occasions. Her blood pressure has never been elevated, and her functional tests have been essentially normal. She undoubtedly has chronic nephritis of a mild degree, and it is quite impossible to tell what is going to happen to her. The immediate prognosis is certainly good, but the ultimate one is doubtful. It is possible that she may recover entirely, she may develop severe diffuse nephritis, in which case she will live only two or three years,

or she may slowly develop a contracted kidney, and may live for many years, to die finally with cardiac hypertrophy and high blood pressure.

CASE 5.—*Severe Chronic.*—Anna B., 11½ years old, was first seen June 8, 1915. She had a rather mild attack of scarlet fever when a baby, and had her tonsils removed six years ago. Otherwise she has been apparently perfectly well up to two weeks prior to admission when her mother noticed that her face and feet were swollen, for which she brought her to the hospital. The child presented the typical picture of what is spoken of in the books as chronic "glomerulo" nephritis. She was very edematous, anemic and in generally poor condition. Her blood pressure was normal, as was her heart. Her urine showed a large trace of albumin, and large numbers of hyaline and granular casts, but no blood.

She stayed in the hospital for about two months, and despite active treatment, was discharged only very slightly improved. She was treated at home by the family physician, and died a year later. This type of case is essentially no different from many cases of chronic nephritis seen in young adults.

CASE 6. *Chronic Nephritis with Infantilism.*—J. C., 7 years old, entered the hospital Jan. 6, 1915, complaining of "bilious attacks."

The family history was negative. He had never been a robust child, but had had no acute infectious diseases. The "bilious attacks" started when he was a year old, and in the last two years had been becoming more frequent. In August, 1914, he began to have these attacks about once a week; now he has them twice a week.

Attack.—He usually wakes up at 3 or 4 o'clock a. m. with headache, crying with the pain. After an hour or two he begins to vomit. The attacks usually last from twelve to twenty-four hours, after which he is fairly comfortable, with the exception of moderate headache, occasionally, until the next one. The attacks seem to have more relation to over-fatigue than to food. He is very thirsty always; drinks a large amount of water, and passes a large amount. Dr. S., the family physician, has examined his urine at least three or four times, and has found it normal at every examination, until a few days prior to admission it was found to contain 0.05 per cent. albumin and a few pus cells in the sediment. No casts or blood.

Physical Examination.—The boy was a much underdeveloped, puny specimen, weighing only 37 pounds. Save for the general poor development, the physical examination was negative. There was a moderate degree of anemia, as shown by a hemoglobin percentage of 65. The urine was examined five or six times during his stay in the hospital, and was always of low gravity (1.008 to 1.012), and always contained a very slight trace of albumin, with a few pus cells in the sediment. It never contained casts or blood. While in the hospital he had no symptoms of any sort, and was discharged with a diagnosis of indigestion and malnutrition, with a question of mild pyelitis. He was admitted again April 21, 1915. Since his discharge from the hospital two months before, his headaches had been continuous, and very severe, so that he always would cry with the pain. The headaches were so severe that his skull was examined by the roentgen ray at another hospital to search for possible tumor. He was also taken to an eminent oculist, who examined his eyes and said that there were one or two small spots on the right retina near the disk, prescribed glasses, but making no diagnosis of any cerebral or severe ocular condition. The "bilious attacks" kept getting worse, so that he was sick either with them or with a headache most of the time. April 16 and 17 there was a good deal of blood in his urine.

Recently the same oculist who had examined his eyes before, looked at them again, and reported a diffuse retinitis of both eyes, which he said looked albuminuric. He entered the hospital the second time for further study. The urine was always of low gravity (1.010 to 1.014) contained very slight traces of albumin, and at most examinations, rare granular casts and a few blood cells.

The phenolsulphonephthalein test was 55 per cent. (definitely low for a child). The systolic blood pressure was 210, the diastolic 120. The aortic second sound was slightly louder than the pulmonic, and there was slight hypertrophy of the heart. The Wassermann test was negative. The urine, the very high blood pressure, and the albumin uric retinitis made the diagnosis of chronic ("interstitial") nephritis seem certain. The boy was discharged from the hospital with a bad prognosis, and has been lost track of since.

The history of this case is given in some detail to point out the difficulty in diagnosing the condition, if it is not being thought of especially. The first time he was in the hospital nobody thought of taking his blood pressure. The second time the urinary examinations and the retinitis put us on the right track, and the blood pressure was taken, which clinched the diagnosis. There are very few of these cases reported in the literature, and undoubtedly one reason for it is that they go unrecognized many times.

III. ETIOLOGY

As we have pointed out before, nephritis in the child must be looked at somewhat differently from nephritis in the adult, because in the child we do not have to consider the wear and tear of the patient's past life, nor do we ordinarily have to think of the circulatory system in relation to the process in the kidneys. As a general proposition, most of the nephritis which has been so extensively studied of late in adults, is chronic nephritis, due to long continued degeneration of the kidney from various causes. In the adult we must consider many things in getting at the etiology of the condition; the presence or absence of syphilis, the abuse of alcohol, the type of life the patient has led for the previous ten or twenty years, and last, and perhaps most important, the condition of the circulatory system. Often it may be hard to decide whether the kidney condition is secondary to circulatory degeneration, or whether the circulatory difficulty is secondary to the kidney condition. This great group of cases, in which the etiology is often so confused, we practically never encounter in children, as we are dealing in most cases with acute processes, and even in the chronic cases the condition has arisen from an acute process from which the kidney has not recovered, and not from a long and slow going degeneration of obscure and remote origin.

In studying the views of the authors of most pediatric textbooks on the etiology of nephritis in children, one finds that most of them consider scarlet fever and cold to be perhaps the two most important etiologic factors, but also state that nephritis *may* occur secondary to many infectious conditions. Tonsillitis is rarely made much of in the etiology, and Still, in his excellent and most practical textbook, calls especial attention to *one* case of nephritis which he

saw after tonsillitis. It has been our experience that *tonsillitis is by far the most frequent cause of nephritis in childhood,* and that one rarely sees the cases secondary to scarlet fever in a general hospital, as most of them either recover entirely or die while in the contagious hospital. Chronic nephritis after scarlet fever is not at all a common condition, as can be seen from Table 1. The table is misleading in that the etiology is classed as "unknown" in too many cases. This is inevitable in any series of hospital cases, where the patients are not seen until some time after they have been taken sick; but it is my belief that in many of the cases which we have recorded as of unknown etiology (because no very definite history was obtainable), the trouble started with a tonsillitis, as in nearly all the children comprising this group the tonsils were large and unhealthy looking. The cases grouped under tonsillitis all came on coincidently with or immediately following a definite tonsillitis.

TABLE 1.—INCIDENCE OF NEPHRITIS FOLLOWING CERTAIN DISEASES

	Acute Nephritis	Chronic Nephritis
Tonsillitis	14	8
Unknown etiology	15*	11*
Scarlet fever	4	4
Impetigo	4	..
Otitis media	4	4
Pneumonia	2	..
Tonsillectomy	2	..
Purpura	2	2
Cervical adenitis	..	1
Carious teeth	2	..
Stomatitis	1	..
Cold	1	..

* Probably tonsillitis in many.

We have seen at least three families in which two or more children have had nephritis at the same time, following sore throats. The nephritis is most likely to occur several days or even a couple of weeks after the onset of the acute tonsillitis, and is likely to be of the pure "hemorrhagic" type without edema, although the "exudative" type, with considerable edema, may occur. Those cases secondary to otitis media and to cervical adenitis come, of course, under the general heading of throat infection. We have seen two cases apparently due to tonsillectomy, and it is not unreasonable to suppose that it is possible for a tonsillectomy to stir up the infectious focus in the tonsils and to disseminate bacteria to such a degree as to cause a nephritis. The practical point to bear in mind in this connection is that tonsillectomy should never be done until the symptoms of acute tonsillitis have subsided. The two cases after purpura

were two unusually severe cases of hemorrhagic nephritis, both of which afterward became chronic, with greatly diminished renal function.

In the last few years much has been written (wisely and unwisely) about teeth as a source of focal infection for various conditions elsewhere in the body. Nearly all of our nephritic children had carious teeth, and we considered it important that these teeth should be put in good order, but in only two cases did it seem reasonably certain that the nephritis was caused by this. In both of these cases the offending teeth were extracted, and large pus pockets were found at the roots.

The conclusions to be drawn are that most cases of nephritis in children are secondary to some acute infection, particularly tonsillitis, and that it is always wise, before discharging such a patient, to examine the urine.

IV. SPECIAL SYMPTOMS

a. General Condition.—One of the most striking things in our series of acute nephritics is that most of the children do not seem very sick; that is, not nearly as sick as one would expect an adult with acute nephritis to be. In our series of forty-nine acute cases there were only eight patients who could be said to be dangerously sick. These were very edematous, with scanty secretion of urine; some of them had headache, increased blood pressure and increased retention of nitrogenous waste products. Of the forty-nine acute cases only one died. This girl was very edematous, with marked oliguria, and had a blood urea of 46 mg. urea per 100 c.c. blood. In most of our acute cases the patients felt perfectly well, with practically no subjective symptoms. In not more than three were there ever any uremic manifestations. We do not mean to give the impression that acute nephritis in childhood is an insignificant affair, for this is by no means true, but we wish to emphasize the fact that it ordinarily does not resemble the usual adult type of case.

Of the chronic cases, thirteen were far advanced, with an expectation of life of months, or a year or two at best. Of these, two died in the hospital, one in uremia, one probably from sudden cardiac dilatation. The rest of the chronic cases were mild, and in a number of them nephritis would never have been suspected if the urine had not been examined.

b. Edema.—Twenty-five of forty-nine acute cases showed varying degrees of edema, sometimes very slight. Only eight of the acute cases had extensive edema. Of the twenty-five subacute and chronic cases, seventeen showed edema.

c. Circulatory System.—In adults, particularly in those with chronic nephritis, elevated blood pressure usually occurs and is sometimes of considerable diagnostic and prognostic importance. In children, save in the small group of cases of which I have spoken as chronic nephritis with infantilism, blood pressure changes are not nearly so important nor so constant.

In 1917 Berkley and Lee[3] reported blood pressure observations on ninety-six nephritic children, many of which were taken on the same cases that form the basis of this paper.

They arrived at the following conclusions:

1. The blood pressure is elevated in the nephritis of childhood, and occasionally to a marked degree. This applies to both acute and chronic nephritis.

2. The blood pressure in chronic nephritis shows no constant elevation above that in acute nephritis.

3. The blood pressure may, in rare instances, be of prognostic value.

4. No relation has been found to exist between the blood pressure and the urinary findings.

5. Patients having marked edema showed a slightly higher average blood pressure than those with little or none. The difference is not great enough to warrant any definite conclusions.

6. Albuminuric retinitis is not common, even in cases showing a marked increase in blood pressure.

In the main, we agree with these conclusions, and would add the following:

1. There are many cases of nephritis in children, both acute and chronic, in which there is no elevation of blood pressure, although it must be constantly borne in mind that the normal blood pressure of a small child is considerably lower than that of an adult, and for this reason a reading of 110 for a child might be relatively as much of an increase as one of 150 for an adult.

2. In acute nephritis an elevated pressure does not necessarily carry with it a bad prognosis, nor does normal blood pressure indicate a good prognosis. One of our fatal acute cases never had a blood pressure above 100, and several of our patients with acute nephritis who entirely recovered had blood pressures of from 130 to 150. In chronic nephritis a normal blood pressure does not mean that the case is a mild one; we have seen a number of advanced cases with normal blood pressures. On the other hand, a consistently and considerably elevated blood pressure in chronic nephritis means that the case is a severe one.

3. Am. J. Dis. Child. **13**:354, 1917.

3. A very low blood pressure in acute nephritis probably means that the adrenals have been involved in the inflammatory process. We have seen one very unusual case of this type. L. J., a physician's son, 6 years old, had a severe tonsillitis, which was followed in about ten days by an apparently mild hemorrhagic nephritis. The nephritis at no time seemed severe; there was never more than a slight trace of albumin in the urine with moderate numbers of red cells, and a rare cast. There was no edema. The father felt that the boy was not getting well as fast as he should, and so asked for a consultation. He seemed in fair condition, and the physical examination was entirely negative save for rather marked muscular weakness, which, however, seemed no greater than might occur after a severe attack of tonsillitis. The most striking thing was the low blood pressure (65). There was no pigmentation, or anything else to suggest Addison's disease. In the next two weeks he grew progressively weaker, his blood pressure was so low that it could not be taken, and he finally died, about three weeks after he was first seen, with no other symptoms than extreme asthenia. Large doses of epinephrin subcutaneously did him no good. Although there was no necropsy, we feel reasonably certain that his death was due to disease of the adrenals secondary to the nephritis.

Cardiac Hypertrophy.—In the nephritis of adults, particularly the chronic form, there is usually considerable cardiac hypertrophy, and in many cases the final fatal outcome may be due as much to cardiac failure as to uremia.

In children, hypertrophy of the heart is not so constant or so striking. Hutinel,[4] however, believes that cardiac dilatation and hypertrophy are common in the nephritis of children.

Friedlander[5] found cardiac hypertrophy present in nearly all of his necropsies on cases of scarlatinal nephritis in children.

Wessler[6] found, by the use of the fluoroscope, combined with percussion, that there was a distinct cardiac hypertrophy in nephritic children, often as early as two weeks after the onset of the nephritis.

Baginsky,[7] on the other hand, says that by clinical methods he could find no evidence of hypertrophy in acute nephritis. In our own series of cases the following was found to be true:

In some cases of acute nephritis, during the most severe stage, there was moderate cardiac dilatation. In practically all the other cases, both acute and chronic, there was not enough cardiac hypertrophy or dilatation to detect clinically.

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4. Bull. méd. de Paris **24**: 1910.
5. Friedlander: Arch. f. Anat. u. Physiol., 1881.
6. Wessler: Arch. Int Med. **14**:516, 1914.
7. Baginsky: Arch. f. Kinderh., 1902, No. 33.

It may be seen from the foregoing that the circulatory changes in the nephritis of children, both as regards hypertrophy of the heart and elevated blood pressure, are by no means so striking or important as they are in the nephritis of adults.

V. FUNCTIONAL TESTS

The same functional tests that are used with adults may be applied to children with nephritis, and we have studied the response of a good many of our patients to some of these tests.[8] Four tests have been used: the added salt and urea test, the determination of the concentration of urea in the blood, the phenolsulphonephthalein test, and the "two-hour renal test," modified somewhat from Mosenthal's procedure. The added salt and urea test, in which it is determined how well a child excretes a weighed amount of salt and of urea added to a standard diet, may be dismissed with the statement that from a practical point of view it is absolutely worthless as far as children are concerned, for the technical difficulties are well nigh insurmountable. The other three tests are, I believe, of some value, although not nearly so great *from a practical point of view as careful observation of the general condition of the patient.* Functional tests, to be of practical use, must be of such simplicity that they can be performed in the home on private patients by the attending physician, and the fact that most of them cannot be done without rather complicated chemical procedures preclude much of this study from being undertaken except in well equipped laboratories by trained chemists.

a. Phenolsulphonephthalein Test.—This test is so easily performed that anybody can do it. It has stood the test of time, and is of considerable practical value. In twenty-seven normal children, we found that phenolsulphonephthalein test varied between 64 and 100 per cent., with an average of 76 per cent. This is considerably higher than the normal figure for adults. The average for twenty-one cases of acute nephritis was 59 per cent., the three lowest figures being 20, 30, and 43 per cent. These figures are considerably higher than a corresponding series of adults with acute nephritis would show.

Several very severe cases showed a normal phenolsulphonephthalein excretion—between 65 and 75 per cent! A low phenolsulphonephthalein excretion in acute nephritis means, simply, I believe, that the patient has a severe nephritis, and does not necessarily carry with it a bad prognosis. A high excretion does not necessarily mean that the prognosis is good. So as far as acute nephritis in chil-

8. Hill, L. W.: Am. J. Dis. Child. **14**:267, 1917.

dren is concerned, the phenolsulphonephthalein test does not seem to be of any great practical value.

Sixteen chronic cases of all degrees of severity showed an average excretion of 63 per cent., 13 per cent. below the normal average of 76 per cent. Several moderately severe chronic cases of long standing, with considerable albumin and many casts in the urine, showed normal phenolsulphonephthalein excretion. One extremely severe case with much edema showed an excretion of 69 per cent.

From this it may be seen that a normal phenolsulphonephthalein excretion does not mean that the child has a mild nephritis with a good prognosis. Repeatedly *low* phenolsulphonephthalein tests, however, mean that the kidney is severely damaged, and that the prognosis is bad.

b. Blood Urea Determination.—We have studied the concentration of blood urea in a few cases (12), and our slight experience would lead us to believe that a high blood urea in either acute or chronic nephritis is of rather bad prognostic significance. No mild or moderately severe case showed a high blood urea. The highest figure, of 46 mg. per 100 c.c. blood, was in a girl with severe acute nephritis, who died suddenly the next day. The blood urea determination would seem to be, in acute cases, a better index of the severity of the nephritis than the phenolsulphonephthalein test. The chemical procedures involved are too complicated, however, for use outside of a hospital.

c. Two-Hour Renal Test.—This test is a delicate and valuable one, and will, I believe, sometimes indicate renal damage when the other tests fail to do so. It cannot be used in cases with edema. It is very simple in its application, and requires no weighed diet or analyses of any sort. The child is simply put on a full diet containing in each meal protein food such as meat and eggs. He is also given 2 grains of caffein sodium benzoate with each meal, and a capsule of salt, containing about 1 gm. The fluid intake is 10 ounces at each meal, and no fluid or food must be taken between meals. The urine is collected in separate bottles every two hours, beginning at 7 a. m. and running through to 7 p. m. The night urine is collected from 7 p. m. to 7 a. m. After this all that is required is specific gravity determination with an ordinary urinometer of each separate specimen. The principle of the test is that a normal kidney varies the concentration of its urine from hour to hour according to the demand on it. With such a diet as the test diet, containing a large amount of nitrogen and of salt, the normal response would be a high gravity in the urine passed after meals, and a considerable lower gravity in the specimens passed before meals.

The diseased kidney is unable to vary the concentration in this way; there is a fixation of specific gravity, and a severely damaged kidney may go on putting out urine from hour to hour and from day to day, which will vary hardly more than a point or two in each specimen. In the original procedure as described by Mosenthal, the nitrogen and salt concentration of each specimen was also determined, but this is not at all necessary; the determination of the specific gravity answers the same purpose. The night urine should be comparatively small in amount, and should have a gravity of 1.020 or over.

TABLE 2.—DATA FROM THE TWO-HOUR RENAL TEST

Normal Response (Normal child 11 yrs. old)		Abnormal Response (Severe chronic nephritis 5½ yrs.)	
Time	Specific Gravity	Time	Specific Gravity
6- 8	1.018	6- 8	1.017
8-10	1.010	8-10	1.018
10-12	1.015	10-12	1.019
12- 2	1.021	12- 2	1.018
2- 4	1.017	2- 4	1.018
4- 6	1.021	4- 6	1.019
6- 6	1.023	6- 6	1.019

We have studied fifteen normal children and have found that in every case there was a difference of at least eight points between the highest and lowest gravity of the two-hour specimens, and usually the difference was considerably greater than this. In every normal case except one, the gravity of the night urine was over 1.020. The amount of night urine in the normals varied too much to determine on any standard of normality. In nearly all of the seventeen cases of nephritis studied by this test there was a definite fixation of gravity, sometimes to an extreme degree, and many cases showed a night urine of low gravity. Most of the patients to whom this test was applied also had phenolsulphonephthalein tests, and in not a few instances the two-hour test showed a damaged kidney where the phenolsulphonephthalein was normal. The two-hour test is so delicate that a good deal of caution is needed in interpreting it, and the general condition of the patient and urine analysis should be carefully considered before deciding that a kidney is severely damaged, even if the urine does show a considerable fixation of gravity.

d. Value of Functional Tests.—In acute nephritis we do not feel that the functional tests are of very great value; we can treat our patients just about as intelligently without them. They are, however, of interest sometimes in confirming the impression that we have formed of the patient by observation of his general condition.

In chronic nephritis the functional tests may be of considerable value, for the purpose of determining how severe a kidney damage

is present, and in deciding the status of the child, as regards prognosis particularly. Normal functional tests probably do not mean a great deal one way or another; repeatedly low functional tests mean a severely damaged kidney, probably with a bad prognosis.

VI. TREATMENT

It is not our intention to discuss in detail the treatment of nephritis, but merely to consider a few of the more important points. The great principle in treatment is to spare the kidneys and to prevent the accumulation of waste products in the blood and tissues. In this connection, diet and the proper use of water play the most important rôles.

Dietary Principles.—The most important constituents of the diet as far as the kidneys are concerned are sodium chlorid and protein. It is the particular work of the kidney to excrete these substances or their end-products, and it is their retention that is the probable cause of many of the untoward symptoms in nephritis. As we have said before, it has been attempted to divide cases of nephritis into two groups, according to whether the difficulty of excretion is with salt or with nitrogenous end-products, but this has been found hardly practical, as it is difficult to tell without complicated laboratory procedures whether a case is primarily of a salt or of a nitrogen retaining type. It is fairly well established, however, that in all edematous cases there is salt retention; therefore it has been our plan to give a salt-free diet to any patient who showed edema. It also seems best, from what is known of nephritis, to keep the nitrogenous intake as low as is consistent with maintaining nitrogenous equilibrium, although it is undoubtedly true that in many cases of both acute and chronic nephritis, in children, at any rate, there is little or no nitrogen retention on a normal protein intake. We believe that it is important to give a fairly large amount of water, *provided the child can handle it,* as water aids greatly in diluting and in elimniating toxins. This is especially important in acute hemorrhagic nephritis, where there is probably in many cases a bacterial invasion of the glomeruli.

These are the most important general principles of the dietetic treatment. In detail the following may be considered:

a. Salt.—There seems no good reason for giving a nonedematous case a salt-free diet. In a case with slight edema the use of salt-free butter and the forbidding of any extra salt is usually sufficient; in a markedly edematous case it is best to use as nearly a salt-free diet as is possible. This means salt-free bread, salt-free butter, vegetables cooked without salt, etc. All of the ordinary

foods contain a certain amount of salt, as can be seen from Table 3,[9] but the small amount contained in most of them does no harm from a practical point of view.

TABLE 3.—Sodium Chlorid Content of Ordinary Foods (Uncooked*)

	Per Cent.		Per Cent.
Mutton	0.14	Oysters	0.52
Beef	0.11	Codfish	0.16
Pork	0.10	Salmon	0.06
Duck	0.14	Halibut	0.30
Chicken	0.14	Eggs	0.21
Oatmeal	0.29	Milk	0.16
Celery	0.25	Cream	0.13
Tomatoes	0.11	Swiss cheese	2.0
Butter (salted)	1.0 –3.0	Edam cheese	3.3
Butter (unsalted)	0.02–0.21	Bread	0.18

Most other cereals, vegetables, fruits and nuts contain less than 0.10 per cent.

*It is probable that more than half the salt in many of these foods would be lost by cooking.

It is often remarkable to see how quickly edema disappears with a salt-free diet, and in many mild cases no other measures are necessary. In more severe cases, such additional procedures as sweating and purging may have to be resorted to. We have followed the sodium chlorid output daily in several of our edematous cases, and below are tables from two cases with a great deal of edema in which no other method of treatment was used than a salt-free diet. The disappearance of the edema was rapid in both.

TABLE 4.—R. M., Aged 6; Acute "Exudative" Nephritis; Edema Excessive

No treatment save salt-free diet

Date	Fluid Intake, C.c.	Urine, C.c.	Salt Output, Gm.
Feb. 18	300	330	1.8
19	300	300	2.0*
20	300	510	4.5
21	600	410	1.5
22	600	410	1.4
23	600	450	1.3
24	600	460	1.2
25	600	585	1.8

*Two pounds loss in weight, on the first two days of salt-free diet.

b. Protein.—There are still many writers who advocate a very much restricted diet in every respect for patients with acute nephritis, but we see no reason why a child with acute or with chronic nephritis should not have as much fatty and carbohydrate food as he wants, with just enough protein to cover his nitrogen needs.

9. Strauss: Praktische Winks fur die chlorarme Ernahrung, Berlin, 1910.

As a matter of fact, there is no good proof that protein does harm in every case of nephritis, but it certainly may in many cases, and inasmuch as it is quite impractical to determine in each case the power of the kidney to excrete nitrogenous waste products, it is only reasonable to cut the protein intake in every case to the minimum which is necessary for the needs of the body. Much work has been done on the minimum protein requirement for adults, but very little investigation has been made with children in different stages of growth. It is generally well known that children need more protein per kilogram of body weight than adults do, but probably 1.5 to 2.0 gm. of protein per day per kilogram of weight is enough for most children to keep in nitrogenous equilibrium. In practice it is usually sufficient to omit meat, eggs and fish from the diet, and it is not necessary to calculate calories or grams of protein, although this is usually done in the hospital. Following is a table (Table 6) of the approximate protein content of ordinary foods, and a typical diet for an acute nephritic. This was given to a boy of five years, weighing 40 pounds, and he kept on exactly the same diet from September 8 to November 22, without tiring of it, or without losing weight.

TABLE 5.—I. M., AGED 4; ACUTE "EXUDATIVE" NEPHRITIS, WITH MODERATE EDEMA

Lost all edema in three days of salt-free diet. No other treatment

Date	Fluid Intake, C.c.	Urine, C.c.	Salt Output, Gm.
Jan. 21	720	625	3.7
22	720	720	3.6
23	720	640	2.0

January 24 three salt capsules each containing a gram of salt were added to his daily diet. His urine excretion continued good; he did not gain weight, and put out the same amount of salt that he did when he was losing edema, and consequently salt, on his salt-free diet.

TABLE 6.—DIET OF J. S. FROM SEPT. 8 TO NOV. 22, 1916

Food	Amount	Calories	Protein, Gm.
Oatmeal	2 tablespoons	70	0.3
16% cream	2 ounces	107	1.8
Sugar	4 drams	100	...
Bread	3 slices	225	0.9
Butter	2 cubes	450	...
Peas	1 tablespoon	40	0.3
Potato	1	70	0.2
Custard	2 tablespoons	110	0.5
Orange juice	6 ounces	78	...
Ice cream	2 tablespoons	77	0.9
		1,327	24.7

TABLE 7.—Caloric Value and Protein Content of Ordinary Foods*

	Calories	Grams of Protein
Whole milk, 1 quart	670	34.0
Skim milk, 1 quart	400	35.0
Gravity cream, 1 pint	860	14.0
Buttermilk, 1 quart	360	35.0
Whey, 1 quart	260	9.0
Beef juice, 1 ounce	10	2.0
Crackers, 1 ounce	120	3.0
Bread, 1 slice	75	3.0
Zwieback, 1 slice	120	3.0
Shredded wheat biscuit	105	3.0
Rolled oats (cooked), 1 tablespoonful	35	1.5
Cream of wheat, and most other cereals (cooked), 1 tablespoonful	40	1.5
Potato, size of large egg	70	2.0
Macaroni, 1 tablespoonful	30	1.0
Egg: whole	72	7.0
Egg: yolk	60	4.0
Egg: white	12	3.0
Meat, Fish: 1 ounce	60	7.0
Bacon, 1 slice = ½ ounce	90	1.5
Butter, 1¼-inch cube = 1 ounce	225	....
Sugar: Milk, 1 round tablespoonful	60	....
Sugar: Cane, 1 round teaspoonful	25	....
Green peas, Lima beans: 1 tablespoonful	40	3.0
Carrots, Squash, Turnip, Beets, Onions: 1 tablespoonful	30	1.0
Orange (medium sized)	50	....
Apple (medium sized)	70	....
Banana	115	2.0
Prunes, 4 without sugar	30	....

*Table used in Children's Hospital, prepared by Dr. J. L. Morse.

In most of the acute cases the child may return to his usual diet as soon as the urine has become normal again, and we feel that often more harm than good is done by keeping a child on a low protein diet over a long period of time. In cases which become subacute, with a few casts and red blood cells continuing in the urine for several months, it is far more important to watch carefully over the child's general health, to try to keep him free from minor respiratory infections, and to prevent him from getting over tired, than it is to closely restrict the diet. In most cases of chronic nephritis in children we believe it is a mistake to restrict the diet very much as regards protein. The child is growing rapidly, and it seems quite unreasonable to keep him on a very low protein intake over a long period of time, especially as there is no good evidence to show that these patients have any impairment of nitrogen excretion. This means that most cases of chronic nephritis should have

meat once a day. Indeed, Epstein has insisted that severe cases of chronic nephritis with considerable edema and a large amount of albumin in the urine should have a larger protein allowance than there is in an ordinary diet, as so much protein is being continually lost in the urine that the protein of the blood serum has become very much diminished. This seems reasonable, and is supported by considerable chemical evidence. The severe chronic cases should be treated as the acute cases, with a salt-free diet.

As von Noorden has said, "Do not treat nephritis by formula, and in the concern for the affected kidneys do not forget the consideration due to the whole organism."

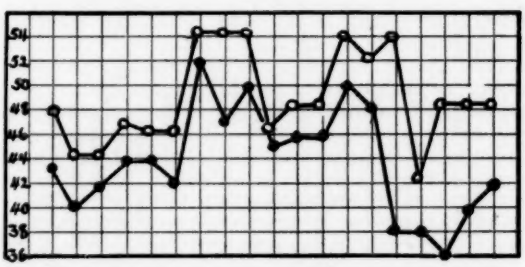

Chart 1.—Showing parallelism between intake and output. O = fluid intake in ounces; ● = urine output in ounces.

c. Water.—Proper regulation of the fluid intake is of great importance in the treatment of acute nephritis, and may be summed up by saying that the patient should have as much water (within reason) as his kidneys can handle. Nearly all cases in children, without edema, can take 48 ounces of fluid daily without showing a gain in weight or edema, and it is our habit to try to keep the fluid intake up to this point in these cases. Even on a constant fluid intake, the twenty-four hour amount of urine may vary within rather wide limits in nephritic or in nonnephritic patients, and as far as we know there has been no work done with children to show how much of the fluid intake should be excreted as urine. The amount of urine depends, of course, to a certain extent, on the character of the bowel movements, and the amount of water lost through sweat and respiration, and so it is quite impossible to fix a definite standard of urinary excretion in response to a given fluid intake. There should be, however, a fairly close parallelism between intake and output—large intake, large output—small intake, small output—which is well shown by Chart 1 from a case of hemorrhagic nephritis, in which there was no impairment of urine excretion. In general, a child should excrete about two-thirds as

much urine as he takes in fluid; if his urine excretion is constantly less than this, he is probably retaining water.

Edematous cases we start on small amounts of fluid, depending on the degree of edema and the amount of urine passed, and then cautiously increase the amount day by day. We have seen few children who could take less than 10 or 12 ounces of fluid a day without a great deal of discomfort, and therefore never attempt to give less than this. If the urine excretion parallels the increased fluid intake we continue to increase; if not, we stop or go back to a smaller amount of fluid. It should be remembered in this connection that considerable fluid may be retained in the tissues and organs before any edema is visible, and therefore, we have every edematous patient weighed every day. If the weight curve rises, we cut down fluid.

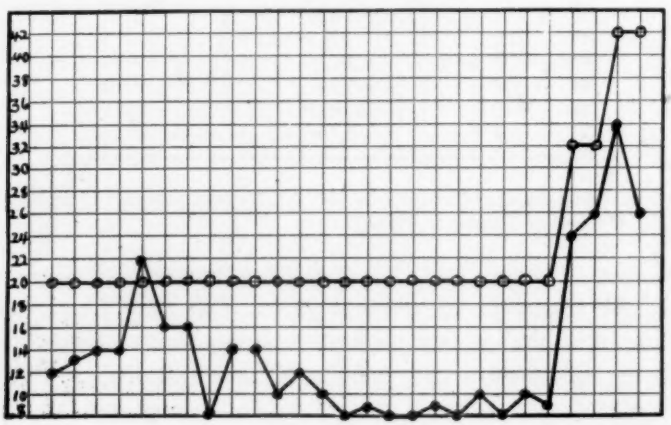

Chart 2.—Showing tolerance for water in spite of edema. O = fluid intake in ounces; ● = urine output in ounces.

Occasionally an edematous patient seems to need a large amount of water; the water acts as a diuretic, and the urine output keeps pace with the increased intake of fluid, or may even exceed it, despite the edema. This is shown in Chart 2. This boy was moderately edematous, and was passing very little urine (8 ounces per day) on a 20 ounce intake. As his intake was inereased (see chart) his output increased with it, and on an intake of 40 ounces a day he passed from 24 to 40 ounces a day many days. Obviously, this particular boy needed a large amount of water, even if he was edematous. Other patients treated in this way might not have been able to handle the increased fluid at all.

Every case of acute nephritis with edema probably goes through a stage in the early part of the disease when the kidneys are relatively impervious to water, with a consequent low output of urine. Later in the course of the nephritis the kidneys are hyperpermeable, with a polyuria. This is well shown in Chart 3. The large drop in weight (54 to 37 pounds) occurring on the same days that there was a polyuria, is very striking, and typical of an acute case of nephritis with edema in the stage of repair.

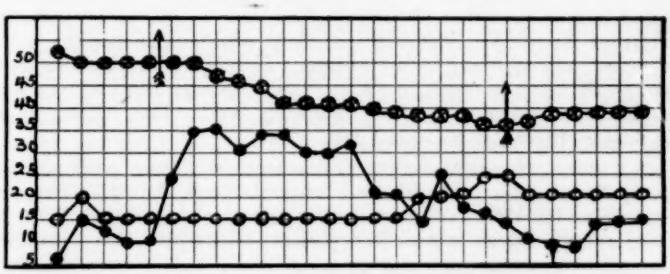

Chart 3.—Showing oliguric and polyuric stages in a case of acute nephritis with much edema. ⊕ = drop in weight in pounds coinciding with polyuria; O = fluid intake in ounces; ● = urine in ounces.

Diuretics.—Most students of nephritis are agreed that diuretics are of no value, and may actually do harm, and for this reason we have not used them in any acute cases. We have used them, however, in several severe cases of chronic nephritis with edema, with excellent immediate results, and no apparent harm. We should not be inclined to use diuretics in any case in which there was much blood in the urine, but in many sluggish, extremely edematous cases, we know from practical experience that theocin or theobromin sodium salicylate may help considerably in getting rid of the edema. Digitalis we have not used, as in children with nephritis there is usually no cardiac weakness.

Edebohls' Operation.—The Edebohls operation was first proposed by Edebohls in 1901 as a cure for chronic nephritis, and consists, briefly, in decapsulation of the kidneys. Edebohls operated on a large series of patients between 1901 and about 1905, and his ideas attracted a good deal of attention. Since then but comparatively few patients have been treated in this way. In 1915 we had at the Children's Hospital an extremely severe case of chronic nephritis in a boy, who would have surely died if he had been left untreated. Dr. Morse proposed an Edebohls operation as a last resort, which was performed, with miraculously good results, so good that the operation has been repeated since then on a number of our patients.

In 1917 Dr. Morse wrote a detailed critical review of the Edebohls operation, discussed all the cases that had been reported up to that time, and reported four of his own cases in which operation was performed at the hospital, and two from his private practice. For a detailed account of these cases the reader is referred to his original paper.[10] Since Dr. Morse's report, four more patients have been thus treated at the hospital, making a total of eight, and these, as well as the earlier cases, are summarized below.

1. Boy, 10 years old, with severe acute "exudative" nephritis, developed uremia and passed no urine for twenty-four hours. The Edebohls operation was performed March 19, 1916, with excellent result. The patient soon began to pass urine, and gradually lost edema. The phenolsulphonephthalein test made March 29, gave a result of 71 per cent. Oct. 5, 1916, the boy was seen in outpatient department, apparently perfectly well. The urine was normal.

Impression: Undoubtedly saved life.

2. Girl, 7 years old, with subacute hemorrhagic nephritis, with much edema; passed very little urine. Admitted to hospital, Dec. 15, 1917. Decapsulation performed Feb. 16, 1918. Very large irregularly shaped red kidneys were found. Operation did no good The patient died about ten days afterward.

Impression: The operation did no good.

3. Boy, 5 5/12 years old, with severe acute "exudative" nephritis; much edema, and very scanty urine secretion. Admitted Sept. 2, 1918, Edebohls' operation performed Sept. 3, 1918. There was improvement immediately following the operation, but the patient became edematous again soon afterward, so much so that his abdomen had to be tapped twice. He was still in the hospital Feb. 14, 1919, very edematous, and had undoubtedly developed a chronic process.

Impression: The operation probably saved life during the acute stage, but did not prevent the development of a chronic nephritis.

4. Boy, 7 years old, had a severe chronic nephritis with much edema; blood pressure 130; very scanty urine secretion. Tonsillectomy was performed and a nonhemolytic streptococcus recovered from a definite pus pocket in the left tonsil. Tonsillectomy did no good; so edematous that abdomen had to be tapped. Edebohls' operation was performed May 14, three months after entrance to the hospital. The operation apparently had no effect one way or the other. July 12, the patient was still edematous, with a urine full of albumin and casts.

Impression: The operation did no good.

5. Girl, aged 5½ years, with very severe chronic nephritis following purpura; very edematous. Phenolsulphonephthalein test, 25 per cent. Decapsulation was done May 4, 1916. One kidney was very small and atrophic, with probably scarcely any kidney tissue left; the other was of the "large white" type. The patient was seen May 13, 1917; still edematous; urine showed a large amount of albumin, with many casts.

Impression: The operation probably did no good.

6. Girl, 10 years old; chronic nephritis, with an acute exacerbation; much edema; urine output very scanty; urine output increased temporarily after operation, but the patient died five days afterward.

Impression: The operation did no good.

7. Boy, aged 11 7/12 years, with severe chronic nephritis, probably from scarlet fever; much edema. On 32 ounces fluid intake he excreted only 7 to

10. Morse, J. L.: J. A. M. A. **69**:525, 1917.

11 ounces of urine. Decapsulation was done May 21, 1918. June 21, no edema; clinically much better. July 23, clinically much better; up and around the ward; looked and felt well. Very slight edema under eyes, but none elsewhere. The urine still contained a large trace of albumin, and a good many hyaline and granular casts.

Impression: The patient was certainly helped a great deal by the operation, but not cured.

8. Boy, 6 years old, with very severe chronic nephritis of three years' duration; acute exacerbation; much edema, so that the boy could hardly see out of his eyes. There was a large amount of fluid in the abdomen; many headaches; very weak; urine contained a large trace of albumin and occasional hyaline and granular casts. Decapsulation was done Oct. 9, 1915. The patient's condition was very bad for about two weeks after the operation, and he nearly died in a severe convulsion. He soon began to improve, and about five weeks after the operation had no edema. The urine contained the slightest possible trace of albumin, and a rare hyaline cast. By the middle of December his urine was normal. He has been seen at intervals during the previous three years; his general condition has always been good, and his urine normal. He was last seen Feb. 12, 1919. The urine showed no albumin, and no casts. It is hard to believe that chronic nephritis can be cured by *any* means, but the operation undoubtedly saved this boy's life, and *seems* to have cured his nephritis.

Impression: Very great and lasting benefit from the operation. The patient would certainly have died without it.

Summary.—Each one of these eight patients was a very severe case of either acute or chronic nephritis, and would undoubtedly have died without the operation, which was done as a last resort in every instance. In four cases it apparently did no good whatever; in one acute case it probably saved life, but did not prevent the development of a chronic process. In one chronic case it helped a great deal. In one acute and in one chronic case it undoubtedly saved life, and apparently cured.

VII. PROGNOSIS

Acute Cases.—In general, the prognosis of acute nephritis in childhood is good. The duration of our acute cases in which the patients recovered entirely is shown in Table 8. By duration, we mean the time from the onset until the urine was albumin-free, and showed no blood or casts in the sediment.

TABLE 8.—DURATION IN ACUTE CASES WITH RECOVERY

2 Wks.	3 Wks.	4 Wks.	5 Wks.	6 Wks.	7 Wks.	8 Wks.	9 Wks.	12 Wks.
1	4	2	3	2	6	6	5	12

As can be seen from Table 8, the usual duration is from six to twelve weeks. In several of the cases which lasted twelve weeks there was still a very small amount of albumin in the urine, but for practical purposes the patients were well. A few of these patients still showed a rare blood cell and a very slight trace of albumin after four or five months, but cleared up eventually. It is our impression that the exudative cases are likely to recover more quickly

than the hemorrhagic, and all of the long drawn out cases were of the hemorrhagic type. Two patients out of fifty-two acute cases died, and four developed chronic nephritis.

Is a child who has had acute nephritis likely to develop chronic nephritis at some time during adult life? Do the cases of chronic renal disease with sclerosed kidneys and high blood pressure that we see during the fifth and sixth decades begin in reality as acute nephritis in childhood, and does the acute nephritis perhaps render the kidney more susceptible to the processes, whatever they may be, that bring about sclerosis of the kidney? These are difficult questions to answers, but we believe it probable that the majority of nephritic children who apparently recover entirely, do so in reality, and that their kidneys are no more susceptible to damage (after a reasonable period of time subsequent to the acute nephritis) than are any other kidneys. In 1911 Ernberg[11] located and examined forty adults who had had acute nephritis before the age of 15, and found normal urines in all. He examined sixteen adults whose acute nephritis had occurred between the ages of 15 and 30 years, and found that all were normal except four. Two of these gave evidence of acute nephritis of recent origin; the other two, whose original attacks had been subacute rather than acute, showed albuminuria.

Chronic Cases.—The most obscure prognosis is connected with the mild chronic cases that we have spoken of, in which the child seems well, has normal functional tests, and merely has as evidence of nephritis, small amounts of albumin, a few casts and a few blood cells occasionally in the urine. We believe that with normal functional tests it is possible for the kidney to recover entirely, and that with low functional tests a more severe and progressive chronic nephritis is likely to develop, but we have not followed these cases long enough to be at all sure of these conclusions. We have seen, however, two or three patients who had this mild albuminuria for over two years, without apparent harm. It is in this type of case that functional tests are of considerable value. In the severe chronic cases, with anemia, much edema, low functional tests, and large amounts of albumin in the urine, the patients rarely live over three or four years, and in most of the fatal cases that we have seen the patients have succumbed before this. The functional tests are, here again, important in determining the expectation of life.

99 Commonwealth Avenue.

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